“ARE YOU A GEEK LIKE MY MOM, OR DO YOU LIKE TO PARTY?” EXPLANATORY BIAS MAY PRECEDE BELIEF IN CAUSAL ESSENCE

BY

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ABSTRACT

Psychological essentialism is the widespread belief that members of natural and social categories share deep, physical properties, or "essences," that cause their common observable characteristics, as well as their identity as category members (e.g., a Chihuahua "essence" causes it to be Chihuahua). The tendency to essentialize is pervasive; it has been documented in children and adults, as well as a number of different cultures (see Gelman, 2003, for a review). However, there is still much to learn about the development of essentialism. What are the origins of essentialist thought? This question remains challenging to answer, particularly because researchers have yet to determine a precise way to measure the belief in a causally powerful essence. The present research had two goals: 1) to refine and validate essentialism measures in order to more accurately capture the belief in a causal essence, and 2) to use these measures to test a possible precursor to essentialist reasoning as a step toward uncovering the origins of essentialist thought.

In Study 1, I adapted measures from the essentialism literature that seemed to best capture the belief in a causally powerful essence. I refined these measures to develop a more precise test of essentialist beliefs. The findings from this study adequately validate my revised measures: 5- to 7-year-old children and adults show developmentally normative essentialist beliefs, in line with previous work. These measures may be useful for researchers interested in examining essentialist beliefs in young children. In Studies 2 and 3, I tested a possible precursor to essentialist beliefs—namely the domain-general bias to explain via inherent information (Cimpian & Salomon, 2014). Previous work shows that essentialist beliefs do not emerge until the age of four. Thus, if inherent thinking is a precursor to essentialism, it should be present before essentialism, perhaps at age three. Using my revised measures, I tested the presence of

essentialism and inherent thinking in three-year-old children. My findings indicate that three-year-old children have yet to develop the belief in a causal essence. However, these children do show early signs of inherent thinking. Overall, these studies suggest that a bias in explanation (i.e., the inherence heuristic) may precede essentialism. This research takes us one step closer toward understanding the developmental course of essentialist beliefs.

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The End.

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CHAPTER 1: INTRODUCTION

"Are you a geek like my mom, or do you like to party?" A seven-year-old boy visiting the lab asked me this question during my first year of graduate school. "My mom says to be successful, you need to be a geek and not a partier," he added. Flustered as his mom watched me, I said "Well, I'm a graduate student, so I guess I'm a geek." Aside from being hilarious, this child's question—and his mom's advice— represent a common element of human reasoning: the tendency to group people and things into discrete categories. This child assumed, like many children and adults do, that knowing whether I was a geek or a partier would tell him something about my character, personality, or ability to be successful. He also thought that "geeks" and "partiers" were mutually exclusive social categories—you could be one or the other, but not both.[1] Categorizing in this way is a pervasive psychological phenomenon—one that considerably shapes human concepts across the lifespan. *Essentialism*, as it is commonly known, is the belief that categories share an unseen, but causally powerful, "essence" that reflects something deep and informative about their members (Dar-Nimrod & Heine, 2011; Gelman, 2003; Kinzler & Dautel, 2012; Medin & Ortony, 1989). Scholars from different disciplines have discussed the tendency to essentialize, and it has also been studied in various cultures (Birnbaum, Deeb, Segall, Ben-Eliyahu, & Diesendruck, 2010; Gelman, Meyer, & Noles, 2013; Rhodes & Gelman, 2009a) and at different points throughout the lifespan (Gelman, Heyman, & Legare, 2007).

Despite its established place in intellectual dialogue, however, there are many remaining questions about the development of essentialist thought. Where does essentialism come from? Although researchers have speculated on this issue (e.g., Gelman, 2003; Gelman & Hirschfeld,

[1] The author does not think geeks and partiers are mutually exclusive categories.
[2] There is arguably no evidence that true, predictive "essences" exist in the world (see Keil, 1995; Leslie, 2013 for

1999), it remains a challenging question to answer. In the literature, conceptions of essentialism often differ from study to study (see Gelman, 2003, for a review). As a result, many different methods have been developed to study essentialism, particularly in early childhood. Findings across a range of procedures point to the robustness of essentialist reasoning—yet, different methods may also be open to different interpretations, making it difficult to develop a clear-cut way of examining precisely how or when essentialism develops. Thus, I have set out to accomplish two goals in the present research. First, I refined and validated essentialism measures in order to more accurately capture the belief in a causal essence. Second, I used these measures to test a possible precursor to essentialist reasoning; understanding the processes or biases that predate essentialism is an important step toward uncovering the origins of essentialist thought.

Before providing details about the current project, I first clarify my approach to defining and studying essentialism by analyzing previous literature on this topic.

Defining and Measuring Essentialism

Different scholars define essences differently (for a review, see Gelman & Hirschfeld, 1999). For my purposes, an essence is an underlying structure or quality, shared by members of a category, that reflects an individual's true (categorical) nature and that causes the similarities shared by individual category members (James, 1890/1983; Locke, 1671/1959; Medin, 1989). Such an underlying structure is not seen or observed directly, but gives a category member its identity and remains unchanged through growth and development. The presumed physical qualities of an essence may vary and will depend on the domain being considered. In the domain of biology, the presumed essence might be something like DNA—a baby human will undergo drastic change and growth as it develops into an adult human, but its DNA will remain unchanged.

Here, I am concerned with essentialism as an intuitive folk theory (that is, as a belief about the world), not as a metaphysical claim about the world per se. Whether essences actually exist in the world is irrelevant to the current research[2]; people believe that they do. These beliefs may be nonspecific—a person could have the intuition that an essence exists, without knowing the form or location of the essence (see R. Gelman, 1990; Keil, 1989; Medin & Ortony, 1989; Wellman, 1990). For example, a child could believe that "mommies" have some inner core that make them distinct from "daddies," without having detailed knowledge about any biological differences between women and men. Indeed, folk beliefs about essences *are* usually vague and implicit, but still inform how people reason about categories.

In order to examine such implicit beliefs empirically, researchers assume that a typical "essentialist" believes:

1) that certain categories are "natural kinds"—that is, they are discoverable in nature, rather than invented—and have clusters of correlated properties (known as the *kind assumption*), and

2) that an unobservable property or feature (i.e., the essence) causes the observed similarities among same-category members (the *essence assumption*; e.g., Gelman, 2003; Haslam et al., 2000; Medin & Ortony, 1989; Newman & Keil, 2008; Prentice & Miller, 2007; Rhodes & Gelman, 2009a; 2009b; see also Bloom, 2000).

These assumptions provide a useful framework for investigating children and adults' tendency to essentialize. Young children do not have the word "essence" in their vocabulary, and, as mentioned earlier, people's beliefs about essences are generally vague and abstract (Medin & Ortony, 1989). Thus, instead of asking children and adults whether they believe in a

[2] There is arguably no evidence that true, predictive "essences" exist in the world (see Keil, 1995; Leslie, 2013 for an extended argument).

causal essence per se, essentialist beliefs are typically examined by measuring downstream or related intuitions that may *follow* from the belief in an essence. Some of these intuitions reflect the *kind assumption*, whereas others reflect the *essence assumption*. One common measure of essentialism, for example, involves people's inductive inferences about categories—that is, whether people generalize a property from one category member to another, over and above perceptual similarities (e.g., Carey, 1985; Gelman & Markman, 1986; Gelman, Collman & Maccoby, 1986; Gelman & Coley, 1990; Markman, 1989). Measures of inductive potential most accurately capture the *kind assumption*: in order to infer one category member's properties from another, one must at least understand that categories are richly structured and share qualities beyond surface similarities. Tasks such as these do not necessarily reflect the *essence* assumption—one could understand that members of a kind will share fundamental qualities, without believing that these qualities are caused by a physical essence (see Gelman, 2003 for argument). In contrast, methods that more closely tap into the *essence assumption* typically rely on people's beliefs about hidden, nonobvious features and their causal importance for categories. Such approaches typically measure whether people believe category membership is innate (Gelman & Wellman, 1991; R. Gelman, 1990; Springer & Keil, 1989), stable over change and growth (Rosengren et al., 1991), and whether people believe that category boundaries are rigid vs. fluid (Kalish, 1995; Rhodes & Gelman, 2009a; 2009b).

Unfortunately, the literature is not always clear about which assumption is under consideration (i.e., kind vs. essence). Moreover, measures of each assumption are used interchangeably to study a vast array of essentialist-like reasoning (see Gelman, 2004). People's beliefs about categories vary largely by domain, and some categories are essentialized more than others (e.g., Diesendruck & Gelman, 1999; Gelman, 1988; Gelman & Gottfried, 1996). In order

to truly understand the nature and complexities of people's concepts, a clear agreement on what is being tested is important.

How should researchers approach measurement development when it comes to essentialist reasoning? One could argue that testing the *essence assumption* (vs. the kind assumption) more accurately captures the general notion of essentialism as a psychological construct. The *essence assumption* naturally incorporates the *kind assumption*—the belief in a causal essence includes the belief in richly structured categories (see Gelman, 2003; Gelman, 2004). In contrast, people can believe that category members share many commonalities *without* considering a causal basis for categories at all. In this way, one may pass the *kind assumption* criteria without passing the *essence assumption* criteria. However, measures should be designed to capture whatever aspect of essentialism is of interest. In the present research, I investigate people's beliefs about a causal, physical essence (and develop measures to do so)—above and beyond the belief that categories have deep commonalities (Goal 1 and Goal 2). Thus, the studies presented will focus on the essence assumption.

Measuring Essentialism: Strengths and Ambiguities

Although defining and measuring essentialism is a challenge, researchers have approached the topic in a number of creative ways. In this section, I describe and review a select group of measures from the essentialism literature that seem most suited to capture the belief in a causal essence (i.e., they test the essence assumption). These measures come closest to assessing the assumption that hidden, nonobvious features are responsible for category membership (see Gelman, 2003). However, there are some aspects of these methods that may make drawing conclusions about children's essentialist beliefs more difficult. A key goal of the present research is to build upon and refine these measures to more precisely capture the belief in a causal essence

(Goal 1). Below, I highlight my concerns involving each of these measures and briefly describe how I plan to address them in the presented studies.

Measuring Essentialism: Metamorphosis. Common essentialism measures test children's beliefs about stability over change and growth (i.e., metamorphosis) for natural kinds vs. artifacts (Hickling & Gelman, 1995; Inagaki & Hatano, 1996; Rosengren et al., 1991). The underlying assumption in these studies is that, if children are essentialist, they should understand that individual animals can undergo drastic metamorphosis over time and remain the same kind (e.g., a caterpillar turning into a butterfly), but artifacts cannot (e.g., turning a TV into a fishbowl changes the kind of thing that it is). Indeed, studies using this method (see Rosengren et al., 1991) have found that young children believe that animals—but not artifacts— can undergo drastic physical metamorphosis (e.g., in shape, size, and color) without changing category membership. These findings are considered evidence for the belief in a causal essence; such reasoning involves an understanding that, for natural kinds, hidden features are a more accurate reflection for category membership than perceptual features are. In order to pass these tests, one must understand that—when it comes to natural kinds—what something *is* cannot be reduced to *what it appears to be*.

However, there are some methodological issues that make interpreting findings such as these difficult. Most notably, these tasks often rely on familiar animal categories, and specifically on information children may have learned in school. Children are explicitly taught from a young age that certain animals undergo metamorphosis (see Rosengren, 1991), and so their performance on these tasks may reflect this specific knowledge instead of an abstract belief in an underlying, causal essence. In fact, other studies have shown that children are less likely to attribute growth over development to more unusual species of animals that they may be less

familiar with (e.g., Inagaki & Sugiyama, 1988). To address this concern, I propose a more conservative test of children's beliefs about stability over metamorphosis: instead of testing children's beliefs about familiar animal categories, I will (1) use *novel* animals and (2) compare children's reasoning about these items with their reasoning about novel artifacts undergoing similar metamorphoses (see Study 1 for additional details). This design will prevent children from reporting previously acquired knowledge of the physical changes certain species undergo as they develop.

Measuring Essentialism: Boundary Intensification. Another important measure of essentialism compares people's beliefs about category boundaries for animals and artifacts (Kalish, 1995; Rhodes & Gelman, 2009a; 2009b). A common assumption in the essentialism literature is that people tend to have domain-specific beliefs about what causes something to be an animal (i.e., nature, or more specifically, its "essence") vs. what causes something to be an artifact (i.e., people invent them); these different beliefs should lead people to be less flexible in how they categorize animal categories vs. artifact categories (Gelman & Koenig, 2003; Gelman & Kremer, 1991; Wellman & Gelman, 1992). If people believe that natural categories, such as animals, are underlain by a causal essence—but artifact categories, such as tools, are not—they should be more likely to think that animal categories are absolute and discrete (e.g., although an atypical example, a penguin is still considered fully a bird, not "sort of" a bird). In contrast, if people understand that artifacts are invented by people, and are therefore at least partly conventional, their beliefs about artifact category boundaries should be more graded and flexible (e.g., a beanbag chair might be "sort of" furniture).

Indeed, people tend to believe that members of natural kinds cannot switch category membership (a dog cannot become a cat, because they have different essences) or that they can

be members of two distinct categories (an individual cannot be both a dog and a cat). In contrast, people are more likely to accept subjective, and even unusual, artifact groupings (e.g., a "spork" is both a spoon and a fork; Diesendruck and Gelman, 1999; Estes, 2003; 2004; Kalish, 1995; 2002). Moreover, people are less likely to agree that two individual animals are the same kind (e.g., believe that a dog and a cat should be grouped separately) than they are to agree that two artifacts are the same kind (e.g., they might agree to group a hammer and a screwdriver together).

In a well-known "boundary intensification" task (Rhodes et al., 2009a), children are asked if two different animals (e.g., a cat and a dog) or two different artifacts (e.g., a car and a train) could be a member of the same kind. The general conclusion drawn from these studies is that, because children tend to essentialize animals (and not artifacts), they believe that animal categories have sharper boundaries than artifact categories. However, there is an aspect of the design of these tasks that makes it difficult to know if children's answers truly reflect the belief that animal categories have less flexible boundaries. Specifically, when referencing the artifact pair (a car and a train, for example), children were asked if the two individuals could be "the same kind of *thing*"; when referencing the animal pair, however, the experimenters asked if the individuals could be "the same kind of *animal*." The wording of these questions might be problematic: "thing" is a more ambiguous classification than "animal," potentially making it easier for children to classify artifacts as the "same kind of thing." Moreover, "things" could be a superordinate category that includes "animals"; had the animal pairs been referred to as "things," children may have been more likely to categorize them as the same kind. Thus, in a revised version of this task (see Study 1), children will be asked if both animal pairs and artifact pairs could be "the same kind of thing."

Measuring Essentialism: Innate Potential. Finally, essentialism measures often test the belief that category membership is determined at birth (see R. Gelman, 1990; Gelman & Wellman, 1991; Hirschfeld, 1996; Springer & Keil, 1989). In these tasks, for example, children are shown a baby animal (e.g., a baby cow) and told that the baby animal was raised in an atypical environment (e.g., a pig farm; Gelman & Wellman, 1991, Study 3). The key question targets children's beliefs about what the baby animal will grow into: a pig or a cow? If children understand that living kinds have "innate potential" (i.e., their mature characteristics are determined at birth), they should understand that a baby animal will remain the same kind as it matures (e.g., a baby calf will grow into a cow), even if it doesn't yet display all of the prototypical characteristics of its category. Such an answer would be considered essentialist.

However, the task above does not rule out the possibility that children were merely reporting category associations. The baby animal's category is explicitly mentioned in the script for this task:

> *"Now I'm going to tell you about a cow named Edith. Look, here's a picture of Edith when she was a baby. Right after Edith was born, when she was just a tiny baby cow, she was taken to a farm that had pigs -- lots of pigs. See, here are the pigs on the farm. The pigs took care of Edith. Edith grew up on the farm with all the pigs, and she never saw another cow."*

Using category labels could convey unchanging category membership. To address this issue, a less familiar—but more controlled—version of the "innate potential" task was developed. Specifically, a revised version of this measure used plants instead of animals (e.g., Gelman & Wellman, 1991, Study 5). Children were shown "a seed" that came from a plant (e.g., a lemon)

that was planted in an atypical environment (e.g., a flower plot), and they were asked what the seed would grow into (e.g., a lemon or a flower). The use of seeds allowed for two key improvements. First, the language used never referred to the seed's category membership (i.e., the experimenter said "a seed that came from a lemon," and never "a lemon seed"). Second, a seed does not resemble the plant it grows into, whereas baby animals may share more physical characteristics with their adult counterparts. In sum, this version of the task rules out the possibility that children are relying on category associations or are simply mapping the perceptual features within kinds.[3] To correctly answer the questions here, children must have some understanding of innate potential—that is, that immature living things will grow into the mature adult of their kind. I will use an adapted version of this task in the proposed studies below.

By being able to more accurately capture the belief in a causal essence (Goal 1; see above), I will also be able to explore a potential precursor to essentialist beliefs (Goal 2), as described in the next section.

The Importance of Examining Essentialism

Essentialism is a pervasive assumption**,** with broad-ranging implications for conceptual development. Thus, understanding the course of its development—and more specifically its potential precursors—is important, and therefore a key goal of the current research (Goal 2). Beginning as early as age four (Gelman & Markman, 1986, 1987; Gelman & Wellman, 1991; Waxman, Medin, & Ross, 2007; for review, see Gelman, 2003), essentialism may influence concepts in useful ways. In particular, essentializing involves understanding the importance of a

[3] It's possible that children may have some explicit knowledge about plant growth (e.g., knowing how seeds grow into plants) that could contribute to their performance on this task. However, children also have explicit knowledge about plant environments (e.g., they know that flowers grow in flowerpots). Thus, children's concepts of innate potential must contribute to their performance on this task, above and beyond their explicit knowledge of plant development (see Study 1 method for more information).

category's hidden, nonobvious properties. When we recognize that internal, perhaps invisible qualities (e.g., DNA) may be more indicative of category membership than outward appearances (e.g., a cat's coat color), we can make useful inferences about category members even when appearances are deceiving. In this way, essentialism involves recognizing that different members of the same category (e.g., two dogs) will have similar qualities even if they have notable physical differences (e.g., both small and large dogs are affectionate) (Gelman & Markman, 1986). In turn, this knowledge may help us to make decisions about individuals without having individual-specific information (e.g., assuming you shouldn't feed an unfamiliar dog chocolate because chocolate makes dogs sick).

More broadly, further examining the development of essentialist beliefs will enhance our understanding of cognitive development. Research in this area has already altered views on children's early concepts. Early developmental theories posited that young concepts are shallow and atheoretical, in that children focus on superficial, perceptual, concrete features (i.e., children's concepts reflect a "what you see is what you get" attitude; Piaget, 1970). According to this view, when children reason about categories, for example, their inferences do not reflect theories about what it means to be a category member (e.g., what it means to be a "dog" vs. a "table"), but instead involve observed perceptual similarities. In a similar vein, more recent accounts stress the influence of perceptual features on early concepts (e.g., Fisher & Sloutsky, 2005; Sloutsky, Kloos, & Fisher, 2007), or more specifically, that concepts undergo a shift across development, such that young children use concrete, surface, or characteristic features during categorization and it's only with age that they recognize the importance of abstract, deep, or defining information (e.g., Bruner, Olver, & Greenfield, 1966; Keil & Batterman, 1984). These accounts suggest that having a theory or set of beliefs about what it means to be a category

should be a relatively late development (see Rhodes & Gelman, 2009a, for a similar argument).

However, the study of children's ability to essentialize contrasts with these accounts and has revealed that as early as age four, children's concepts may be more similar to those of adults than traditional accounts suggest. Childhood essentialism supports a "theory theory" view of cognitive development: across many studies, it has been found that young children do not simply make associations regarding perceptual similarities, but are able to search for causal explanations and use information beyond the obvious[4] (for reviews, see Gelman, 2003; Wellman, 1990). Thus, understanding the developmental course of essentialist thinking may, in part, reveal the processes that underlie children's early conceptual development and shed light on the level of sophistication in children's concepts even before age four.

Finally, studying essentialism may help researchers understand how to prevent its negative consequences. Essentialism involves the belief that categories, including social kinds, are natural and based in biology. Such a belief often leads people to overlook critical variation within categories (e.g., believing that African Americans share many intellectual traits) and to exaggerate dissimilarities between different groups (e.g., believing that African Americans and Caucasians have many innate intellectual differences). In turn, these inferences often motivate stereotyping, prejudice, and endorsement of inequalities (Bastian & Haslam, 2006; Dar-Nimrod & Heine, 2011; Haslam et al., 2002; Haslam & Whelan, 2008; Keller, 2005; Levy, Stroessner, & Dweck, 1998; Prentice & Miller, 2007; Williams & Eberhardt, 2008; Yzerbyt et al., 2001). Importantly, such judgments are generally inaccurate, as biological differences within a social category, such as those that reflect race or ethnicity, are just as likely as biological differences across different social groups (Graves, 2001; Lewontin, Rose, & Kamin, 1984; Templeton, 1999;

[4] See the General Discussion for more on this issue.

for extended argument, see Leslie, 2013). Understanding the development of essentialism may help us to understand how these erroneous beliefs are formed in the first place, and how we may prevent any subsequent harmful ramifications. In the section below, I review possible sources of essentialist beliefs and propose a potential precursor.

What Contributes to the Development of Essentialism?

My second goal here is to examine a potential precursor to essentialism. Although it has been suggested that essentialist assumptions reflect the true structure of the world (e.g., Bloom, 2000; Kornblith, 1993; Pinker, 1994), there is little support for the notion that essentialized categories possess true, discoverable, essences (Dupré 1981; Leslie 2013; Maglo 2011; Mayr, 1991; Needham, 2011; Sober 1994). However, people still believe that they do. What might lead to the formation of these beliefs? In this section, I will discuss what the literature to date has proposed as possible sources of essentialist beliefs. I will also highlight the importance of examining potential precursors.

Some accounts suppose that essentialism is a byproduct of culture or history (Fuss, 1989; Guillaumin, 1980). For example, as people have gained greater access to scientific knowledge relating to biological or nonobvious entities over time (like DNA), essentialism could reflect this shift in scientific understanding (Fodor, 1998). However, essentialism as a byproduct of a more scientifically informed society does not explain why children seem to essentialize categories before formally learning scientific or biological principles (Gelman & Coley, 1990). Moreover, essentialism is found to be present during early childhood in a variety of cultures, even in those with an explicitly non-essentialist belief system (e.g., the Vezo people of Madagascar do not consider "Vezo" identity to be inborn or biological, yet Vezo children appear essentialist on a

number of traditional essentialism tasks; see Astuti, 2000), suggesting that it may begin to develop without instruction (Atran, 1993; Berlin, 1992).

In a similar vein, others have proposed that cultural messages via language may be largely responsible for the development of essentialist beliefs (Carey, 2000; Waxman, Medin, & Ross, 2007). However, children are able to form categories even in the absence of language (Baldwin, Markman, & Melartin, 1993; Mehler & Fox, 1985), and parents rarely mention essences in everyday talk with their children (e.g., Gelman, et al., 1998). Moreover, there seems to be a mismatch between children's early conceptual knowledge and the conversations they have with their parents. That is, young children have complex beliefs about insides, causality, and natural kind origins (see Gelman, 2003), but parents do not discuss these topics with their children (Gelman, et al., 1998). It's more likely that cultural cues help strengthen or facilitate already existing essentialist tendencies (e.g., beliefs about insides or causality), rather than give rise to essentialism on their own (see Gelman, 2003). Specifically, linguistic cues may subtly convey category coherence, leading children to take on essentialist attitudes in some respects. For example, children tend to essentialize categories referenced in generics[5] (e.g., "Lions have manes") more than they essentialize categories referenced in nongenerics (e.g., "This lion has a mane"; see Cimpian, 2013; Gelman & Tardiff, 1998; 2004; Gelman et al., 2010; Rhodes, Leslie, & Tworek, 2012). Generics do not convey the existence of an essence directly, but generic statements about a category may imply that the relationship between a category and its properties is stable (e.g., "Bears climb trees" suggests that bears as a category tend to climb trees, and that this is a stable characteristic of bears), and thus influence the extent to which a particular category is essentialized (Gelman & Heyman, 1999; Gelman, Ware, & Kleinberg, 2010; Rhodes

[5] Generic statements describe a kind or category as a whole, rather than an individual member (Leslie, 2008).

et al., 2012; Segall, Birnbaum, Deeb, & Diesendruck, 2015). Thus, culture seems to contribute to the development of essentialism in more indirect ways.

Another possibility is that essentialism is an evolved domain-specific, biological module (e.g., Atran, 1998; Gil-White, 2001; Pinker, 1994). However, there is reason to believe that examining essentialism as a domain-specific, innate capacity may not be the best way to understand the development of essentialism. For one, people also essentialize categories in non-biological domains, including socially determined kinds (Haslam, Rothschild, Ernst, 2000). Moreover, children begin to essentialize both animals and social groups around the same time and to similar degrees (Rhodes & Gelman, 2009a; Taylor, Rhodes, & Gelman, 2009). Also, the evidence to date suggests that essentialism may not appear until the age of four (see Gelman, 2003), suggesting that essentialism itself is not an innate capacity.

Given that essentialism doesn't seem to come from culture alone and is unlikely to be an evolved capacity, a fruitful endeavor may be to examine domain-general cognitive capacities or biases that might predate essentialism. There are a number of abilities found quite early in development that seem closely related to the belief in an "essence." Beginning as early as infancy, young children can differentiate appearances from underlying reality (Bloom, 2001; Flavell, Flavell, & Green, 1983), understand that many properties are caused (Bullock, Gelman, & Baillargeon, 1982; Gelman & Kalish, 1993; Shultz, 1982), believe that self-propelled objects possess an "internal energy" source (Baillargeon, Wu, Yuan, Li, & Luo, 2009), and believe that nonobvious qualities are often causally responsible for category-typical properties (Gelman, Coley, & Gottfried, 1994). These and other such capacities may be present at birth and later form into more specific beliefs about essences (see Keil, 1995; Gelman, 2003).

Recent work in social and cognitive psychology suggests that another domain-general process may contribute to the development of essentialism. Specifically, it has been proposed that the bias to explain via inherent information (i.e., the inherence heuristic) influences the extent to which children and adults essentialize (Cimpian & Salomon, 2014; Salomon & Cimpian, 2014; Sutherland & Cimpian, 2014). As young children attempt to make sense of the world, they are likely to explain patterns and entities in their environment in terms of their "inherent" characteristics. These inherent features involve an entity's makeup (e.g., coffee is bitter and has caffeine), and are not essences; they are not considered the causal source of an entity's category-typical properties. In the present research, I suggest that this broader explanatory bias is present before the onset of essentialist beliefs. Given that these two constructs are related in important ways (Salomon & Cimpian, 2014; Sutherland & Cimpian, 2014), knowing whether inherent thinking precedes essentialism will bring us closer to understanding how essentialist beliefs are formed in the first place.

Below, I outline how explanation proceeds via the inherence heuristic and the relationship of this heuristic to essentialism. Then I describe the predictions I will test here.

The Inherence Heuristic as a Precursor to Essentialism

People are driven to understand the world, and strive to do so via explanation (e.g., Keil, 1996; Ross, 1977). The task of generating explanations is, in principle, quite complex (Hummel, Licato, & Bringsjord, 2014; Landy & Hummel, 2010; Thomas, Dougherty, & Buttaccio, 2014), as it requires us to access and apply existing knowledge to new situations when faced with an unknown (Ahn et al., 1987; Vosniadou & Brewer, 1987). However, our cognitive systems tend to simplify the process. Specifically, we often make sense of the world heuristically (Chaiken & Trope, 1999; Gilovich, Griffin, & Kahneman, 2002; Kahneman, 2011; Toplak et al., 2013).

Under this assumption, when we make judgments and decisions, we retrieve information from memory that is most accessible and salient and use that information to form our explanations. A recent account provides a framework for understanding the content of this information. Specifically, the *inherence heuristic* (Cimpian & Salomon, 2014) proposes that when we explain aspects of our environment, we are most likely to consider the *inherent* characteristics of what we're trying to explain (Cimpian & Salomon, 2014). These inherent features involve an entity's makeup (e.g., coffee has caffeine) and are distinct from relevant but non-constitutive features, such as an entity's environment or place of origin (e.g., Arabica coffee beans are grown in Colombia). According to the inherence heuristic account, inherent features come to mind before external factors, making them the focal point of many explanations. Consider, for example, the following question: Why is coffee black? An immediate response may be to look for something about the properties of coffee (or, more specifically, of coffee beans) that might explain this. However, such immediate inherent explanations are often misleading. Coffee beans are actually green—it's not until they are roasted that they begin to darken. Thus, coffee's dark color is not (just) a result of the inherent properties of coffee beans, but rather in large part a downstream consequence of how people use them to make coffee. However, people tend to overlook such external factors when generating explanations and instead rely on more salient and easily retrievable inherent features (Hussak & Cimpian, under review).

Even when extrinsic information may lead us to more accurate answers, the tendency to explain heuristically biases the content of our explanations such that we use inherent information more often than extrinsic information. Notably, the tendency to explain via inherent information is pervasive (Cimpian & Salomon, 2014; Cimpian & Markman, 2009; 2011; McRae et al., 2005; Salomon & Cimpian, 2014). It emerges early in childhood, and remains a prominent feature of

cognition over the course of development (Cimpian & Steinberg, 2014). Moreover, the tendency to explain via inherent information seems to be a domain-general one: children and adults explain a variety of phenomena inherently, including ones involving non-essentialized entities such as artifacts, words, and behaviors (Gelman, 2003; Hussak & Cimpian, 2015; Keil, 1995; Salomon & Cimpian, 2014; Sutherland & Cimpian, 2014; Tworek & Cimpian, 2016).

Importantly, inherent features are not essences. An "essence" is internal, non-obvious, and microstructural; inherent features do not necessarily have these properties. By definition, essences determine category membership and cause category-typical characteristics; inherent features may not. An inherent feature may be characteristic, and even defining, but does not necessarily hold the causal responsibilities of an essence. Moreover, the inherence heuristic itself is not a belief at all— it is instead a process of explanation that, downstream, may inform a number of our beliefs. In contrast, essentialism may involve explanatory processes or biases, but it is defined as a specific belief about natural and social categories. In this way, explanation via the inherence heuristic may be a more basic process than essentialism. Thus, it seems plausible that the broad tendency to explain via inherent information precedes the development of the specific belief in a causally powerful essence.

More broadly, how might the inherence heuristic lead to more specific beliefs about essences? If children begin to make sense of the world by invoking inherent information about the patterns and regularities they experience, these explanations may, downstream, lead to more specific beliefs about essences. After habitually invoking inherent features via the explanation process, children may notice, and come to assume, that *many* patterns seem to have an inherent cause. This assumption, along with other early-emerging beliefs—such as the belief that many properties have causes (Keil, 1989; 1994), or the belief that self-propelled objects have an

"internal energy" (Baillargeon, Wu, Yuan, Li, & Luo, 2009)—may lead to the specific belief that certain kinds have a causal essence.

Predictions of the Account: Inherent Thinking as a Precursor to Essentialism

Several considerations suggest that the inherence heuristic may serve as a precursor to the formation of essentialist beliefs. For example, adults' tendency to explain via inherent information predicts their tendency to essentialize, over and above a number of related constructs (Salomon & Cimpian, 2014). Moreover, manipulating the tendency to explain inherently leads to changes in essentialism, for both adults (Salomon & Cimpian, 2014) and children (Sutherland & Cimpian, in preparation). Here, I test another prediction of this account—specifically, whether inherent explanations are present *before* the onset of essentialism. As essentialism emerges by the age of four (Gelman & Markman, 1986, 1987; Gelman & Wellman, 1991; Waxman, Medin, & Ross, 2007; for review see Gelman, 2003), I predict that 3-year-olds will demonstrate reliance on the inherence heuristic but will lack clear signs of essentialist reasoning (specifically, the essence assumption, as discussed above). If this prediction holds, I will have provided additional evidence for the claim that inherent thinking is a precursor to essentialism. The current set of studies tests whether three-year-old children indeed reason inherently but still lack mature essentialist thought.

The Present Studies

The research presented here has two goals. The first is to develop and validate measures that test children's beliefs about a causally powerful essence. I predict that by age 5, children will show developmentally normative essentialist beliefs on these measures, in line with previous work. The second goal of this research is to examine a possible precursor to essentialist beliefs—namely, inherent thinking. I predict that children will show signs of this early, domain-general

cognitive bias before they show signs of essentialism. If essentialist reasoning indeed precedes inherent thinking, then there should be a time in development in which inherent thinking is present but essentialism is not. Providing such evidence would serve to support previous work suggesting that inherent thinking may be a precursor to, or lay the foundation for, essentialist beliefs. Essentialism seems to emerge no earlier than age four (e.g., Gelman, 2003). Thus, the studies presented here will compare essentialist reasoning and inherent thinking before age four—namely, at age three.

In Study 1, I validate measures of essentialism designed to capture the belief in a causal essence (i.e., test the essence assumption). The participants in this first study were adults, as well as 5- and 7-year-old children. I tested these age groups in order to validate the new measures with age groups previously found to have essentialist beliefs (Rhodes & Gelman, 2009a; 2009b; Gottfried & Gelman, 2005; Gelman & Wellman, 1991; for a review, see Gelman, 2003). In Studies 2 and 3, I test my second prediction, that at age 3, children will show signs of inherent thinking but not the essence assumption.

CHAPTER 2: STUDY 1, DEVELOPING MEASURES

The goal of Study 1 was to develop, revise, and validate new measures of essentialism that most accurately capture the belief in a causal essence. Here, I refined previous measures of essentialism that may have involved ambiguous interpretations. As I was interested in testing the belief in a causal essence, I adapted, and made critical changes to, measures from previous work that most closely measured the *essence assumption*. Specifically, I measured a) the belief that category membership is determined at birth, b) beliefs about category stability over change and growth, and c) beliefs about category boundaries. An "Innate Potential" task tested the belief that an individual's true nature is inborn and cannot be changed by its rearing environment. A "Metamorphosis" task tested the belief that living things (but not artifacts) retain their category membership over drastic physical change and growth.[6] A "Boundaries" task tested the belief that children assume stricter category boundaries for animal categories than for artifacts (e.g., believing an individual is either in the category or outside the category because it either possesses the category essence or it does not; Rhodes & Gelman, 2009a; 2009b). Each of these tasks relies on the understanding that hidden, nonobvious features are more indicative of category membership than salient perceptual properties, and thus tap into the *essence* assumption over and above the *kind* assumption (see Gelman, 2003).

To validate these new measures, I tested them in three age groups: adults, as well as 5- and 7-year-old children. Children have been found to reason in an essentialist manner by the age of 5, especially when reasoning about natural kinds, such as animals (e.g., Rhodes & Gelman, 2009a, 2009b). However, as children age, they seem to develop a better understanding that nonobvious qualities (e.g., an animal's insides) are often more informative and indicative of

[6] Beliefs about innate potential and beliefs about stability over change and growth are conceptually similar, in that they both involve an understanding of the importance of nature vs. nurture during development.

category membership than perceptual features (e.g., an animal's color) (e.g., Gelman & Wellman, 1991; Gottfried & Gelman, 2005). Thus, if the measures revised here indeed tap into children's understanding of an unseen yet causally powerful essence, I should find that essentialist beliefs as captured by these tasks are present at age five and increase by age seven. Additionally, I would expect to find that essentialist beliefs tend to remain present in adulthood on these measures.

Finally, it is important to note that different essentialist beliefs (e.g., the belief that category membership is innate or the belief that category membership is stable over time) are not always correlated, especially in studies with children below the age of nine (e.g., Gelman et al., 2007). Therefore, I do not expect that children will show coherence across measures of essentialism (although ideally measures of the same construct should in fact correlate), but this coherence may improve by adulthood.

Method

Participants. There were 3 groups of participants: adults, five-year-olds, and seven-year-olds. These age groups were chosen to validate the essentialism tasks with samples previously found to engage in essentialist reasoning (e.g., Gelman, 2003). Fifty-eight adults (M_{age} = 37.98 years, *SD* = 12.18; 25 men and 33 women) were recruited from Amazon's Mechanical Turk service and paid $0.50 for participating. Three additional adults were tested but excluded from the final sample for failing to pay attention. Thirty-two 5-year-old children (M_{age} = 5.41 years, *SD* = .23; 16 girls and 16 boys) and 32 7-year-old children (M_{age} = 7.79 years, *SD* = .48; 16 girls and 16 boys) were recruited from a small city in the Midwestern United States. Seven additional children were tested but excluded from the final sample because they refused to complete the study. The participants were mostly European American and represented a variety of

socioeconomic backgrounds.

Procedure. Both children and adults were administered the three essentialism tasks (Innate Potential, Boundaries, and Metamorphosis), whose order was counterbalanced across participants. An experimenter presented the tasks to children orally and adults completed the tasks online via Qualtrics. At the beginning of the survey, adults were told that they would be completing tasks designed for children.

Innate Potential Task. To test the belief in innate potential, I adapted a task from Gelman and Wellman (1991). This task examines the belief that an individual's true nature, or "essence," is inborn. Participants were asked to identify the type of plant that ultimately grew from a seed (e.g., a seed that came from a lemon) that had been planted in an atypical environment (e.g., a cornfield). The questions were worded so as to avoid implying category membership (i.e., the seed was not called a "lemon seed," but instead a "seed that came from a lemon"). I did not use animal categories (as the original study in this series did) because baby animals and adult animals often share notable physical similarities, and so children might group them together based on shallow, outward appearances. Moreover, it is difficult to ask about animal categories without mentioning category membership (e.g., "this is a cow"). Using seeds instead of animals in this task takes care of these issues: seeds do not share perceptual features with the plants they grow into, and they may be referenced without calling attention to category membership. Thus, children must understand that a seed and its plant share some unobservable, inner quality for a seed to grow into a very different looking plant over time. If children correctly identify the ultimate plant, they must think that nature (vs. nurture) is more indicative of category

membership.[7] During the task, participants were asked about three different seeds (orange, lemon, and rose) that were planted in three different environments (flower pot, cornfield, and vegetable garden, respectively). Answers to these questions were coded on a 0/1 scale (0 = category membership determined by environment; 1 = category membership determined by seed/nature) and averaged across trials, with higher scores indicating more "essentialist" responses.

Metamorphosis and Category-Boundaries Tasks. In order to present children the next two tasks (i.e., Metamorphosis and Boundaries), I modeled a procedure after Rhodes and Gelman (2009a): Children were introduced to a colorful puppet named "Feppy" and told that Feppy was from a far-away place "where they do lots of things differently than we do" and that "some of the things they do are wrong, but some of the things are just different." Children were told that their job during the tasks was to tell the experimenter when "Feppy and his friends say something *wrong* and when Feppy and his friends say something that is *may be right*, but just different." Adults read this information on their computer, and a picture of Feppy was used in place of the physical puppet.

In these tasks, participants were asked to evaluate Feppy's opinion on a number of animal and artifact pairs (e.g., "Feppy and his friends think that these two things are the same kind of thing. Are they maybe right?"), many of which contained very different looking individuals, or individuals that were unlikely to be members of the same category. I used "maybe right" as an option in this task in order to set a low bar for a "yes" response; this element of the design allows

[7] As mentioned earlier, it's possible that children's explicit knowledge about seeds may inform their answers in this task. However, children also have explicit knowledge about plant environments, making seed vs. environment a strong contrast. To confirm that children indeed know the plants that typically grow in certain environments, I asked a separate sample of 4- to 7-year-old children, about their knowledge of plant environments (e.g., "Do you know what grows from a flowerpot? What grows from a flowerpot?). 10 of 12 children successfully answered the questions about all three environments (flowerpots, cornfield, vegetable garden) used in this study.

participants to consider the possibility that two distinct individuals may be members of the same category, even when it seems unlikely. Otherwise, participants might always respond with "no," making it difficult to adequately measure the relative differences between people's beliefs about animal categories and their beliefs about artifact categories.

Metamorphosis. To test beliefs about constancy over transformations, I adapted a task from Rosengren et al. (1991). The questions were designed to capture children's understanding that members of natural categories (e.g., a caterpillar) can undergo drastic perceptual change (e.g., turn into a butterfly) and remain a member of the same category. If children assume stability of category membership over such metamorphoses for essentialized categories, they should agree that a baby animal could change drastically as it matures (e.g., in shape and size) and retain its category membership, but that a brand-new artifact could not (e.g., a tool does not change in shape over time). Here, I showed children pictures of novel animals (e.g., a Dax) and artifacts (e.g., a Blick) so that their answers would indeed capture beliefs about metamorphosis, and not information that had been learned in school (such as understanding that caterpillars turn into butterflies). During the task, children were shown a picture of a baby animal or a new artifact, followed by a second, very different looking picture. Pictures were black and white, and all the same relative size.[8] Referencing the second picture, an experimenter asked children the following question: "Feppy and his friends all say that this is what [Daxes/ Blicks] look like [when they are adults/ after they have been used for a while].[9] Are they maybe right?" If children have the notion of a persistent, internal, causally powerful essence (which generally applies to animals, but not artifacts), they should be more likely to agree that the second, very different

[8] A norming study confirmed that adults perceived the artifact pairs (old vs. new; $M = 3.72$, $SD = 1.64$) and animal pairs (baby vs. adult; $M = 3.91$, $SD = 1.61$) as equally similar on a nine-point similarity scale (1 = "not at all similar" to 9 = "extremely similar").

[9] Children were asked two questions to ensure they understood the meaning of "adult" (i.e., "Are you an adult?" and "Are your mom and dad adults?"). In the rare case that children got these questions wrong, they were corrected.

looking animal might be the first animal as an adult, than to agree that the second, very different looking tool could be the first tool later in time (see Appendix A for a full description of measures). Responses were coded on a 0/1 scale (yes = 1; no = 0), and averaged across animal and tool trials separately. Children's Metamorphosis score was calculated as a difference score (Animals - Tools), such that higher scores indicated more "essentialist" responses.

Category Boundaries. To test children's beliefs about category boundaries, I adapted a task from Rhodes and Gelman (2009a) (which was itself modified from the original task used in Kalish, 1998). The questions were designed to examine whether children hold stricter category boundaries for animals than for artifacts. Specifically, children were asked if it was "maybe right for Feppy and his friends to think" that two different animals (e.g., a cat and a dog) or two different artifacts (e.g., a car and a train) could be the same kind.

I made a small but critical change to the questions from the original Rhodes and Gelman task. In the present study, when referencing both the animal pair and the artifact pair, children were asked if the two target individuals could be "the same kind of *thing*." As mentioned previously, in the original task, children were asked if the individuals in the animal pair could be the same kind of "animal" (and "thing" was used only for artifacts). Using "animal" rather than the broader "thing" may have made it more difficult for children to group the two animals as the same kind, leading children to appear less flexible about animal categories than artifact categories. By asking whether both the animal pairs and the artifact pairs are "the same kind of thing," I should be able to obtain a more accurate measure of how strict children are about category boundaries for animals vs. artifacts.[10] In this revised task, if children are more likely to

[10] To some extent, children's performance on this task may rely on their knowledge of superordinate category words (e.g., "animals", "tools") vs. subordinate category terms ("cat", "car"). However, this aspect of the design makes my test particularly conservative. Three-year-olds know the word animal, for example, but words such as "tool" or "vehicle" are not yet in their vocabulary (Frank et al., 2016). Thus, children may be more likely to reference the

say that two artifacts could be the same kind of thing than two animals, then it's likely that children have stricter category boundaries for animals than for artifacts.

The individuals in both the animal pairs (e.g., a grey-white cat and a black dog) and the artifact pairs (e.g., a blue car and a yellow train) had distinct perceptual features. Thus, if children believe that animal categories cannot overlap (but artifacts can sometimes), they must recognize that something beyond perceptual properties (i.e., an essence) is responsible for animal category membership.

Participants were asked about two animal pairs (grey-white cat/black labrador; turtle/orange frog) and two artifact pairs (hammer/screwdriver; blue car/yellow train). Responses were coded on a 0/1 scale (yes = 1; no = 0), and averaged across animal and tool trials separately. Scores on the Boundaries task were calculated as a difference score (Tools - Animals), with higher scores indicating essentialist reasoning.

Difference scores for Metamorphosis (Animals – Tools) and Boundaries (Tools – Animals) were taken, and then participants' scores on each measure were converted to a –1 to 1 scale (–1 = anti essentialist; 0 = neutral; 1= essentialist) for ease of interpretation. An average of the three measures (Innate Potential, Boundaries, Metamorphosis) was computed to create a composite Essentialism Score (for a full description of means, see Table 1). For a full description of measures, please see Appendix A.

Results

The goal of Study 1 was to validate my revised measures of essentialism intended to precisely tap into the belief in a causal essence**.** If the new tasks used here indeed measure

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subordinate categories ("car", "train") when asked about artifacts (tools and vehicles, specifically) than when asked about animals, making it less likely for them to say that two artifacts vs. two animals could be "the same kind of thing."

essentialist beliefs, then participants generally considered to be essentialist—adults and children over the age of 5 (Gelman, 2003; Gottfried & Gelman, 2005; Gelman & Wellman, 2001; Rhodes & Gelman 2009a; 2009b)—should answer in an essentialist manner on my revised tasks. Moreover, I expect essentialist beliefs to increase between age five and age seven, and to be present in adulthood as well (e.g., Gelman & Wellman, 1991; Gottfried & Gelman, 2005).

First, I examined adults' mean responses on the essentialism tasks. In line with previous work, I predicted that adults would be essentialist on these measures. One-sample *t* tests were conducted to determine if adults' composite Essentialism scores were significantly different from a neutral response (0 on a –1 [anti essentialist] to 1 [essentialist] scale). The composite Essentialism scores for adults ($M = .38$, $SD = .04$) were significantly higher than zero, indicating essentialist reasoning, $t(57) = 9.65$, $p < .001$. Moreover, adults' scores were significantly greater than zero on Innate Potential ($M = .77$, $SD = .06$), $t(57) = 11.91$, $p < .001$, Metamorphosis ($M = .27$, $SD = .07$), $t(57) = 40.02$, $p < .001$, and Boundaries ($M = .11$, $SD = .05$), $t(57) = 2.09$, $p = .041$ Thus, adults' reasoning seems to be essentialist on each of these measures (rather than neutral or anti-essentialist), in line with previous work in the essentialism literature done with adults (Gelman, 1988; Gelman & O'Reilly, 1988). In other words, the adult data reported so far indicate that these new tasks seem to be a fair measure of the belief in a causal essence.

Next, I analyzed the data from five- and seven-year-olds. These samples were examined separately, as I expected children's essentialism to increase with age. I predicted that children would reason in an essentialist manner by age five, and that their essentialism should increase by age seven. One-sample *t* tests were conducted to determine if children's Essentialism scores were significantly different from a neutral response (0 on a −1 [anti essentialist] to 1 [essentialist] scale). The composite Essentialism scores for 5-year-olds ($M = .26$, $SD = .28$) were significantly

higher than zero, indicating essentialist reasoning, $t(31) = 5.16$, $p < .001$. Seven-year-olds showed a similar pattern ($M = .38$, $SD = .24$), with a composite Essentialism score significantly higher than zero, $t(31) = 8.75$, $p < .001$. Overall, seven-year-olds' Essentialism scores were marginally higher than five-year-olds', $t(31) = 1.88$, $p = .07$.

When examining children's scores on the individual measures of essentialism, five-year-olds' Innate Potential scores were above chance ($M = .77$, $SD = .55$), $t(31)= 7.91$, $p < .001$, but their Boundaries and Metamorphosis scores were not significantly higher than the midpoint, both ps $> .05$. At seven, both children's Innate Potential scores ($M = .83$, $SD = .38$), $t(31) = 12.45$, $p < .001$, and their Metamorphosis scores ($M = .20$, $SD = .47$), $t(31) = 2.43$, $p = .02$, were significantly higher than zero. Seven-year-olds' Boundaries scores were not different from zero ($M = .83$, $SD = .38$), $t(31) = 1.44$, $p = .161$. (For means, see Table 1.)

Like adults, five-year-olds and seven-year-olds appear to reason in an essentialist manner, and children's essentialism scores tend to increase with age. Moreover, children tend to be essentialist on more measures as they age. If the revised measures truly capture essentialist beliefs, then children and adults' scores on these new measures should reflect findings from studies done with similar samples. That is indeed what I found: in line with previous work, children show signs of essentialist reasoning at age five. Moreover, essentialism increases by age seven, and it remains stable into adulthood. As the findings reported here reflect those found in similar samples, it seems as though the revised measures indeed capture the belief in a causal essence, in line with Goal 1.

Finally, I examined the relationship between the individual essentialism measures in each sample. Adults' Innate Potential scores and their Metamorphosis scores were significantly correlated, $r(56) = .27$, $p = .037$, but their Boundaries scores were not correlated with either of

the other two measures, both *p*s > .59. (For correlation matrix, see Table 3.) Overall, adults had a low Cronbach's alpha across these measures (α = .29). For both five-year-olds and seven-year-olds, none of the essentialism measures were significantly correlated (see Table 3 for correlation matrix; αs = .37 and .27, respectively). However, this is similar to what was observed in prior work. As essentialism is difficult to capture and measures of it are very different from one another, individual measures of essentialism are not always strongly correlated (e.g., Gelman et al., 2007). This coherence may improve with age, however (though typically not before age 9; e.g., Gelman et al., 2007); in our own data, adults' scores were significantly correlated on two of the three measures, whereas children's essentialism scores were not interrelated.

The findings reported here provide some evidence for the validity of my revised essentialism tasks. As children age, they are more likely to privilege hidden, nonobvious qualities over shallow, perceptual features in their reasoning about kinds, and essentialist reasoning of this sort remains stable into adulthood.

Key to achieving Goal 1, I developed a set of measures to precisely measure the belief in a causal essence. To date, researchers have not settled on a single way to define and measure essentialism, leading to a number of different methodologies. Moreover, a number of the popular measures of essentialism—in particular, those that most closely tap into intuitions about a causal essence—involve issues that make it difficult to interpret their findings. Here, I made critical improvements to measures that most closely capture the belief in a causal essence. The work accomplished in this study fills an important gap in the essentialism data reported across the developmental literature. These measures may help inform our understanding of children's early essentialist concepts and may be used in future work examining the belief in a causal essence.

Figures and Tables

Table 1: Essentialism Scores Across Age Groups, Study 1

Measure	Mean	Std. Dev.	95% CI	p
5-year-olds				
Innate Potential	0.77	0.55	0.57, 0.97	<0.001**
Metamorphosis	−0.06	0.40	−0.21, 0.08	0.380
Boundaries	0.06	0.44	−0.09, 0.21	0.423
Average	0.26	0.28	0.16, 0.36	<0.001**
7-year-olds				
Innate Potential	0.83	0.38	0.70, 0.97	<0.001**
Metamorphosis	0.20	0.47	0.03, 0.37	0.021*
Boundaries	0.09	0.37	−0.04, 0.23	0.161
Average	0.38	0.24	0.29, 0.46	<0.001**
Adults				
Innate Potential	0.77	0.49	0.64, 0.90	<0.001**
Metamorphosis	0.26	0.50	0.13, 0.40	<0.001**
Boundaries	0.11	0.41	0.01, 0.22	<0.05*
Average	0.38	0.30	0.30, 0.46	<0.001**

$N = 122$.

*$p < .05$. ** $p < .001$.

Note: Scores could range from −1 (Anti-Essentialist) to 1 (Essentialist). Asterisks indicate significant difference from 0 (the midpoint).

Table 2: Descriptive Statistics for Metamorphosis and Boundaries Tasks, Study 1

	5-year-olds		7-year-olds		Adults	
Measure	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Metamorphosis						
Animals	0.56	0.44	0.61	0.38	0.57	0.67
Tools	0.63	0.40	0.41	0.35	0.43	0.41
Boundaries						
Animals	0.27	0.35	0.22	0.33	0.62	0.60
Tools	0.33	0.43	0.31	0.38	0.69	0.72

Note: Responses for both Metamorphosis and Boundaries items were coded on a 0/1 scale (yes = 1; no = 0), and averaged across animal and tool trials separately.

Table 3. Correlations between individual essentialism measures, Study 1

Five-year-olds

Measure	1.	2.	3.
1. Innate Potential	—		
2. Metamorphosis	−.12	—	
3. Boundaries	.29	−.07	—

Seven-year-olds

Measure	1.	2.	3.
1. Innate Potential	—		
2. Metamorphosis	.20	—	
3. Boundaries	−.12	.02	—

Adults

Measure	1.	2.	3.
1. Innate Potential	—		
2. Metamorphosis	.27*	—	
3. Boundaries	.07	−.02	—

*$p < .05$.

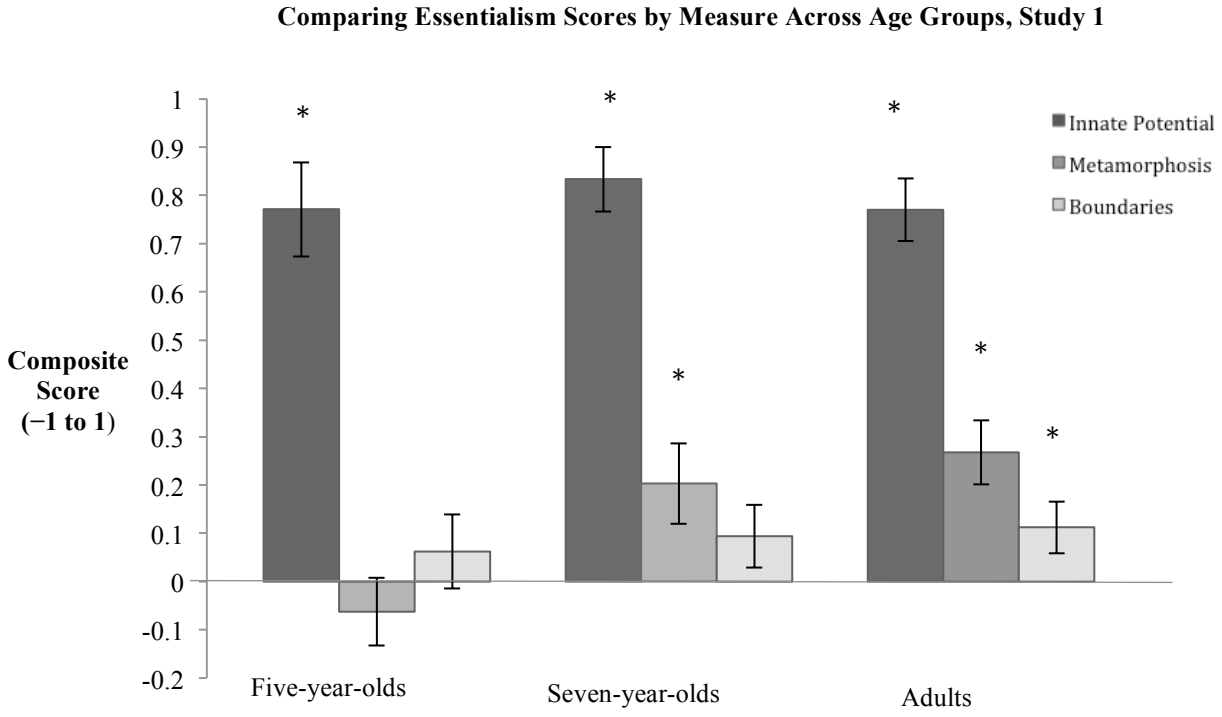

Figure 1. Comparing Essentialism Scores by Measure across age groups (five-year-olds, seven-year-olds, and adults, respectively). Individual essentialism scores could range from −1 (Anti-Essentialist) to 1 (Essentialist). Innate Potential scores were calculated as an average of three items. Metamorphosis scores were calculated as a difference score (Animals – Tools), as were Boundaries scores (Tools – Animals). Asterisks indicate significant difference from zero.

Composite Essentialism Scores by Across Age Groups, Study 1

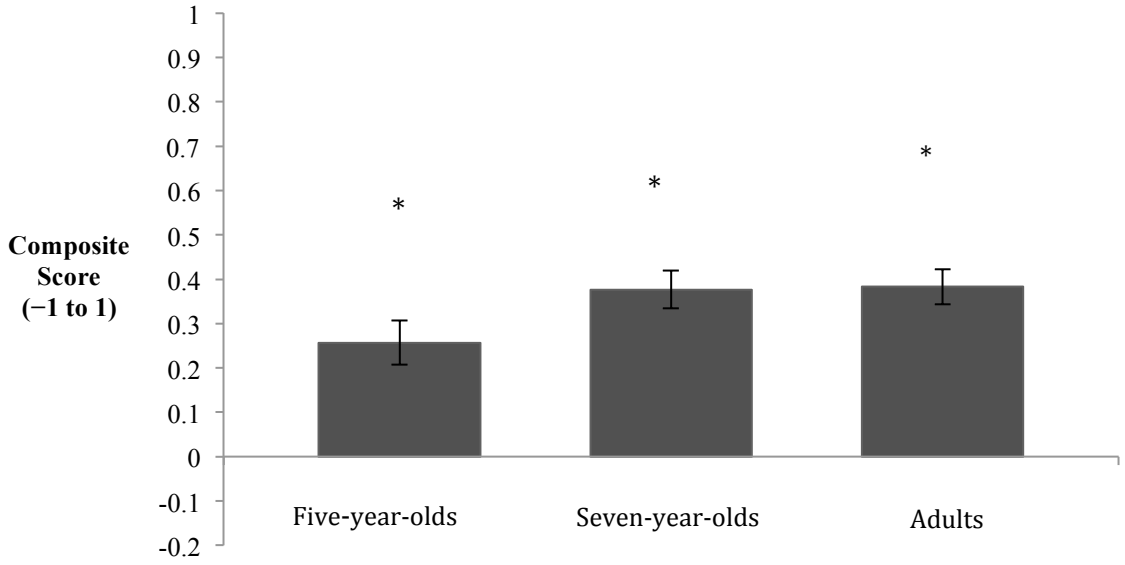

Figure 2. Composite Essentialism Scores across age groups (Five-year-olds, seven-year-olds, and adults, respectively). Scores could range from −1 (Anti-Essentialist) to 1(Essentialist). Composite scores were calculated as an average of the three essentialism tasks: Innate Potential, Metamorphosis, and Boundaries. Asterisks indicate significant difference from zero.

CHAPTER 3: STUDY 2, INHERENT THINKING AS A PRECURSOR TO ESSENTIALISM

In Study 1, I accomplished my first goal, which was to develop and refine measures that capture the belief in a causal essence. These measures would also be central in achieving my second goal—to test a possible precursor to essentialist beliefs of the sort discussed here. In Study 2, I tested the prediction that three-year-olds show signs of inherent thinking, but not the belief in a causally powerful essence (i.e., the "essence assumption"). Here, three-year-old children completed the essentialism measures developed in Study 1, as well as a measure of inherent thinking designed for young children. I compared children's responses on these measures to examine if they appear to reason inherently but do not show signs of essentialist thinking, as predicted. If my prediction holds true, then this study would provide additional evidence that the bias to explain inherently serves as a precursor to essentialism.

Method

Participants. The participants were 32 3-year-old children (M_{age} = 3.75 years, SD = .28; 16 girls and 16 boys) who were recruited from a small city in the Midwestern United States. The children were mostly European American and represented a variety of socioeconomic backgrounds. As a study of this nature (i.e., one relying on verbal skills) might be difficult for three-year-olds, I took extra precaution to ensure my final set of participants understood the tasks. In order to be included in the study, children needed to pass a strict inclusion criterion (see below for details); this screening is important in studies that rely on predominantly verbal material with such a young age group. An additional 21 children were excluded from the study based on this criterion. Eleven additional children were tested but excluded from the final sample because they refused to complete the study.

Materials and Procedure. The materials in this study measured 1) children's essentialist reasoning and 2) children's tendency to rely on inherent thinking. The items were divided into two blocks ("measures"), and the order in which these blocks (as well as the individual items within them) were presented was counterbalanced across participants.

Essentialism Measure and Catch Questions. Children's essentialist reasoning was assessed using the measures developed in Study 1 (Innate Potential, Metamorphosis, and Boundaries) ($\alpha = .26$).[11] In this study, however, I added catch questions to the end of the essentialism measure to rule out the possibility of a yes-bias and to ensure that three-year-olds properly understood the task. Specifically, I asked children two catch questions: one that required a "yes" response ("Feppy and his friends all say that baseball is a sport. Are they maybe right?"), and one that required a "no" response ("Feppy and his friends all say that your name is Sammy. Are they maybe right?"). In order to be included in the study, children needed to get both questions correct.

Inherent Thinking. To measure children's reliance on the inherence heuristic, I adapted a measure used in prior work on this topic with young children (Cimpian & Steinberg, 2014; Sutherland & Cimpian, 2015). This measure was a composite that consisted of three items ("Explanation", "Stability", and "Changeability") aimed to capture children's explanatory intuitions more broadly (see Sutherland & Cimpian, 2015). Children tend to reason inherently about a broad range of phenomena, such as many social-conventional patterns. Importantly, many of these patterns do not fall under the scope of categories typically essentialized by young children. As I wanted to test the prediction that children reason inherently before the onset of

[11] Due to this low alpha, all analyses will be reported for individual Essentialism scores. However, as it is not uncommon for essentialism studies to collapse across measures with a low alpha, I will also be reporting composite scores.

essentialism, it was important to measure children's inherent thinking in a non-essentialized domain. Thus, in this set of measures, I asked children about two social-conventional patterns (i.e., *birthday cakes having candles* and *coins being round*).

Explanation. The first item in this measure asked children to indicate their agreement with inherent and extrinsic explanations for everyday, social-conventional patterns (e.g., birthday cakes having candles). As it would be too difficult for three-year-olds to generate their own explanations in this task, I asked them to evaluate explanations instead. Moreover, I presented them with relatively broad explanations that might cover the range of inherent explanations children could, in principle, come up with on their own (e.g., birthday cakes have candles "just because they are birthday cakes"). The extrinsic explanations were similarly broad (e.g., birthday cakes have candles "just because people thought it might be a nice idea"). If children rely on the inherence heuristic, they should agree with inherent explanations more than extrinsic explanations. Each child evaluated an inherent and an extrinsic explanation for each of the two patterns. After each explanation was presented, the experimenter asked the child whether they thought it was "right" or "not right"; as a follow-up, the experimenter asked the child to further rate their agreement (i.e., "Is it *a little* [right/ not right] or *really* [right/ not right]?"). Thus, children's responses to these "Explanation" questions were ultimately scored on a four-point scale (1 = "really not right" to 4 = "really right"). Children's answers to each explanation type were averaged across trials, and then children's evaluations for the inherent and extrinsic explanations[12] were averaged to create a composite Explanation score.

Stability and Changeability. The other items in the measure of inherent reasoning tapped intuitions that follow closely from inherent explanations. Inherent explanations often make the

[12] Children's answers to the extrinsic explanations were reverse-scored.

pattern under examination appear necessary or obligatory (see Tworek & Cimpian, 2016, for extended argument). Thus, the next sets of questions in this measure were designed to capture children's beliefs about the necessity of conventional patterns. In one set of questions, children were asked to indicate whether they thought everyday patterns remained stable over time (e.g., "Do you think birthday cakes will always have candles, even way into the future when the last birthday cake is made?"). Children's responses to these "Stability" questions were rated on a "yes/no" scale (0 = no, 1 = yes). If children reason inherently by age three, then they should agree that conventional patterns are necessary, and thus remain stable over time.

In another set of questions, children were asked if these patterns were changeable (e.g., "Imagine if people wanted birthday cakes to not have candles, and everyone agreed that they wanted birthday cakes to not have candles. Would it be okay to make a change so that birthday cakes do not have candles?"). Answer options were "yes" or "no" to this question. If they responded "no," children were asked a follow-up question: namely, if it was "sort of not okay," "not okay," or "really not okay" to make this change. Children's responses to each of these two questions were scored as follows: −1 = "okay"; .33 = "sort of not okay"; .66 = "not okay"; 1 = "really not okay". Children's answers were then aggregated across items to create a composite Changeability score, with higher scores indicating more inherent thinking. This scale was coded such that the midpoint ("0", in this case) would reflect neither anti-inherent nor inherent reasoning. Thus, scores below "0" reflected "anti-inherent" reasoning and scores above "0" reflected "inherent" reasoning. If children rely on the inherence heuristic, and believe many patterns to be obligatory, they should think it's "not okay" to change a social convention (for a similar argument, see Cimpian & Steinberg, 2014).

Pattern order (i.e., *birthday cakes* and *coins*) as well as item order (i.e., Explanation, Changeability, and Stability) was fully counterbalanced across participants. For ease of comparison with the essentialism measures, children's scores for the Explanation and Stability measures were also converted to a scale from −1 (anti inherent) to 1 (inherent), with 0 as the neutral midpoint. A composite "Inherent Thinking" score was calculated as an average of the three measures (Explanation, Stability, Changeability; $\alpha = .15$).[13] For a full description of measures, please see Appendix A.

Results

The goal of Study 2 was to test a possible precursor to the belief in a causal essence. Previous accounts have proposed that an early-emerging bias to explain inherently precedes essentialist beliefs (Salomon & Cimpian, 2014; Sutherland & Cimpian, 2014). Here, I test a specific prediction of this account: that three-year-old children would show signs of inherent thinking, but not yet show signs of the belief in an essence. For this prediction to be supported, children's essentialism scores should be below or no different from the midpoint of the scale (0 on a −1 [anti-essentialist] to 1 [essentialist] scale), but their inherence heuristic scores should be significantly higher than the midpoint (0 on a −1 [anti-inherence] to 1 [inherence] scale). At the level of individual children, if inherent thinking is indeed a precursor of essentialist beliefs, it should be more likely for essentialism to occur in the presence of inherent thinking than in the absence of inherent thinking. Similarly, I would also predict that it should be more likely for inherent thinking to be present in absence of essentialism than for essentialism to be present in absence of inherent thinking. In other words, I should find that more children are "inherent thinkers" but not "essentialists" than children who are "essentialists" but not "inherent thinkers."

[13] As with the Essentialism scores, I will report analyses on individual measures of Inherent Thinking due to the low alpha. However, I will also report a composite score in order for ease of comparison to the essentialism data.

Means and Correlations. To test whether three-year-olds have yet developed the belief in a causal essence, I examined their mean levels of essentialism. First, I conducted a one-sample *t* test to determine if children's composite Essentialism scores were significantly different from a neutral response (0 = neither essentialist nor anti-essentialist). As predicted, three-year-olds' composite Essentialism scores (M = .01, SD = .29) were not significantly different from zero, $t(31) = 0.17$, p = .865. These results suggest that three-year-olds did not engage in essentialist reasoning. Moreover, three-year-olds' scores were not significantly different from zero on any of the three essentialism measures (Innate Potential, Metamorphosis, and Boundaries; all *p*s >= .05) (see Table 4 for full description of statistics). As predicted, three-year-old children do not seem to have the notion of a causal essence as tested here. Moreover, none of the essentialism measures were significantly correlated, all *p*s > .05 (see Table 8 for full correlation matrix), which might be expected given that three-year-olds do not seem to have these beliefs yet, and because essentialism measures often do not begin to cohere until later in development (see Gelman et al., 2007).

Next, I examined three-year-olds' mean levels of inherent thinking. If inherent thinking precedes essentialism, then three-year-olds should show signs of inherent thinking. A one-sample *t* test was conducted to determine if a statistically significant difference existed between children's Inherent Thinking scores (M = .22, SD = .35) and a neutral response (0 = neither inherent nor anti-inherent). As predicted, three-year-olds' Inherent Thinking scores were significantly above the neutral mid-point, $t(31) = 3.54$, $p < .001$. Additionally, I conducted a paired-sample *t* test to examine whether children's composite Essentialism scores and Inherent Thinking scores were significantly different from each other. Three-year-olds' Essentialism scores were indeed significantly lower than their Inherent Thinking scores, $t(31) = 2.46$, p = .02.

The data reported so far indicate that three-year-old children show early signs of inherent intuitions, but do not seem to possess the belief in a causal essence.

Finally, I examined three-year-olds' scores on each inherent thinking measure separately. Only their Stability scores ($M = .66$, $SD = .59$) were significantly different from zero, $t(31) = 6.31$, $p < .001$. Children's Changeability scores ($M = -.03$, $SD = .79$) and their Explanation scores ($M = .03$, $SD = .39$) did not differ from zero, both ps $> .05$ (see Table 4). Thus, three-year-olds show signs of inherent thinking, but this evidence is only apparent on measures of Stability. Notably, children's scores on these measures were not correlated with one another, all ps $> .05$ (for full correlation matrix, see Table 8); this result might be explained by the fact that young children's explanatory biases were not strong on measures of changeability or explanation. If children do not have strong beliefs about the necessity of patterns (i.e., changeability beliefs) or about the reasons those patterns exist (i.e., explanation evaluations), it may be difficult to pick up any meaningful variability in such biases.

Individual Response Patterns. The results reported thus far suggest that three-year-old children show early signs of inherent thinking but have not yet developed the belief in a causal essence. Another way to test the claim that inherent thinking develops before the belief in a causal essence would be to test whether essentialism is more likely to be present when inherent thinking is also present than when inherent thinking is not present. Additionally, at the individual level, three-year-old children should be more likely to be "inherent thinkers" but *not* "essentialists" than they are to be "essentialists" but *not* "inherent thinkers." In order to examine this possibility, I first classified children as inherent thinkers (vs. non-inherent thinkers) and essentialists (vs. non-essentialists). Children were considered inherent thinkers if their answers leaned towards inherence on 2 of the 3 Inherent Thinking questions (i.e., Stability,

Changeability, and Explanation). Similarly, children were considered essentialists if their answers leaned towards essentialist reasoning on 2 of the 3 Essentialism questions (i.e., Innate Potential, Metamorphosis, and Boundaries). For details regarding this classification system, see Table 5.

I first tested whether there were more essentialist children among inherent thinkers than among non-inherent thinkers. Although the relative frequencies trended in the predicted direction (23.1% essentialists among inherent thinkers vs. only 10.5% among non-inherent thinkers), a Fisher's exact test indicated that the difference was not significant, $p = .374$. A related prediction of the proposal that the inherence heuristic is a precursor of essentialism is that there should be significantly fewer children who are essentialists but not inherent thinkers than children who are inherent thinkers but not essentialists. To test this prediction, I looked specifically at children who were classified in one category but not the other ($n = 12$), leaving out any children who were in neither or both. A binomial test revealed that, in this subset of children, there were indeed significantly fewer children who were essentialists only (2 of 12 children) than children who were inherent thinkers only (10 out of 12), $p = .04$. These results are in line with the claim that inherent thinking may develop earlier than the belief in a causal essence.

Discussion. Overall, these data seem to suggest that even when there are no signs of essentialist reasoning, there are early signs of inherent thinking, particularly the belief in the stability of patterns over time. Note that the patterns in question (i.e., coins, birthday cakes) are not patterns that children typically essentialize. Thus, children as young as three seem to be engaging in a cognitive process conceptually distinct from essentialism, but that may nevertheless serve as a precursor to essentialism. Although children did not score high on all measures of inherent thinking, their intuitions about the stability of societal patterns were quite

strong. It's possible that children's early inherent intuitions are best captured by their beliefs about the stability of patterns over time, or questions about stability are easier for young children to grasp than those reflecting other inherent intuitions. In fact, these findings are consistent with developmental studies on the inherence heuristic. Young children's Stability scores tend to be much higher than their Changeability and Explanation scores (see Cimpian & Steinberg, 2014). However, one could argue that children's answers to the stability questions simply portray a yes-bias, as "yes" reflected an inherent response on all these questions. Although I included catch items to rule out this possibility, those catch items were part of my Essentialism measure, not the Inherent Thinking measure. I address these and other possible issues in Study 3.

Figures and Tables

Table 4: Three-year-olds Essentialism and Inherent Thinking Scores, Study 2

Measure	Mean	Std. Dev.	95% CI	p
Essentialism				
Innate Potential	0.10	0.75	−0.17, 0.37	0.438
Metamorphosis	0.02	0.43	−0.14, 0.17	0.839
Boundaries	−0.09	0.37	−0.23, 0.04	0.161
Average	0.01	0.29	−0.09, 0.11	0.865
Inherent Thinking				
Stability	0.66	0.59	0.44, 0.87	0.001**
Changeability	−0.03	0.79	−0.32, 0.25	0.825
Explanation	0.03	0.39	−0.11, 0.17	0.709
Average	0.22	0.35	0.09, 0.34	0.001**

$N = 32$.

*$p < 0.01$. ** $p < 0.001$.

Note: Scores could range from −1 (Anti-Essentialist) to 1(Essentialist) or −1 (Anti-Inherent) to 1(Inherent). Asterisks indicate significant difference from 0 (the midpoint).

Table 5. Classification system to categorize children as "inherent thinkers" or "essentialists"

Inherent Thinking Questions (using *birthday cakes have candles* fact)	**Classified as "Inherent" if…**
Stability (2 items, 4 questions total): **a.** Do you think birthday cakes have always had candles, even way back when the first ever birthday cake was made? Have birthday cakes always had candles? **b.** Do you think birthday cakes will always have candles, even way into the future, when the very last birthday cake is made? Will birthday cakes always have candles? Scoring: 0 = "no", 1 = "yes"	Gave predicted answer ("yes") on a majority of the questions (3 out of 4.)
Changeability (2 items, 2 questions total): Imagine if people wanted birthday cakes to not have candles, and everyone agreed that they wanted birthday cakes to not have candles. Would it be okay to make this change? Would it be okay to make a change so that birthday cakes do not have candles? *Children could respond with "yes" or "no." If they responded with "no," the experimenter asked a follow-up:* Would it be sort of not okay, not okay, or really not okay to make a change so that birthday cakes don't have candles? Scoring: 4-point scale (1 = "okay" to 4 = "really not okay")	Gave predicted answer ("no") on both questions.
Explanation (2 items, 2 inherent and 2 extrinsic responses total): Ok, so one person said that birthday cakes have candles…. **[EXTRINSIC]:** … just because people thought it might be a nice idea. But birthday cakes don't really have to have candles. Is this person right or not right to think that birthday cakes have candles just because people thought it might be a nice idea? * **[INHERENT]:** …just because they are birthday cakes. And birthday cakes have to have candles. Is this person right or not right to think that birthday cakes have candles just because they're birthday cakes? *Children could respond with "right" or "not right." The experimenter followed-up with a scale for each response.* Scoring: 4-point scale (1 = "really not right" to 4 = "really right") * Indicates reversed scoring	Agreement with inherent explanation was greater than agreement with extrinsic explanation (before reversed-scored) for both items.

Table 5 (cont.)

Essentialism Questions	**Classified as "Essentialist" if…**
<u>Innate Potential (3 items, 3 questions total)</u> This seed came from an [orange/lemon/rose]. A girl named Jennifer took this seed out of the orange. Then she planted the seed in a [flower pot/ cornfield/vegetable garden]. See, here's the [flower pot/cornfield/vegetable garden]. Now I'm going to ask you some questions. So where did the seed come from? And where did [Jennifer/Ashley/Lauren] plant this seed? When that seed grew, what popped up out of the ground, was it an orange tree or a flower? <u>Scoring</u>: 0 = "environment", 1 = "seed"	Gave predicted answer (going with the seed) on a majority of the questions (2 out of 3).
<u>Metamorphosis</u> **Animals (2 items, 2 questions total):** Here is a baby [Dax/Frip]. [Daxes/Frips] are animals. And this is a baby [Dax/Frip]. Here is another picture. Let's see what Feppy says about this new picture. Feppy and his friends ALL say that this is what [Daxes/Frips] look like when they are adults. Are they maybe right? [Yes/ No] **Tools: (2 items, 2 questions total):** Here is a brand new [Blick /Joop]. [Blicks/Joops] are tools. And this is a brand new [Blick/Joops] (point again). Here is another picture. Let's see what Feppy says about this new picture. Feppy and his friends ALL say that this is what [Blicks/Joops] look like after they have been used for a while. Are they maybe right? [Yes/ No] <u>Scoring</u>: 0 = "no", 1 = "yes"	Gave the predicted answer ("yes" for animals, "no" for artifacts) on a majority of the questions (3 out of 4).
<u>Boundaries (4 items, 2 tool and 2 animal questions)</u> Here are a couple of things. Let's see what Feppy says about them. Feppy and his friends ALL say that these are the same kind of thing. Are they maybe right? [Yes/ No] <u>Scoring</u>: 0 = "no", 1 = "yes"	Gave the predicted answer ("no" for animals, "yes" for artifacts) on a majority of the questions (3 out of 4).

Note. Children were classified as "Inherent Thinkers" if their answers were "Inherent" on 2/3 of the Inherent Thinking questions. Children were classified as "Essentialists" if their answers were "Essentialist" on 2/3 of the Essentialism questions.

Table 6. Frequency of *inherent thinkers* and *essentialists* in Study 2

	Inherent Thinkers		
Essentialists		Yes	No
	Yes	3	2
	No	10	17

Composite Essentialism Scores by Across Age Groups, from Studies 1 and 2

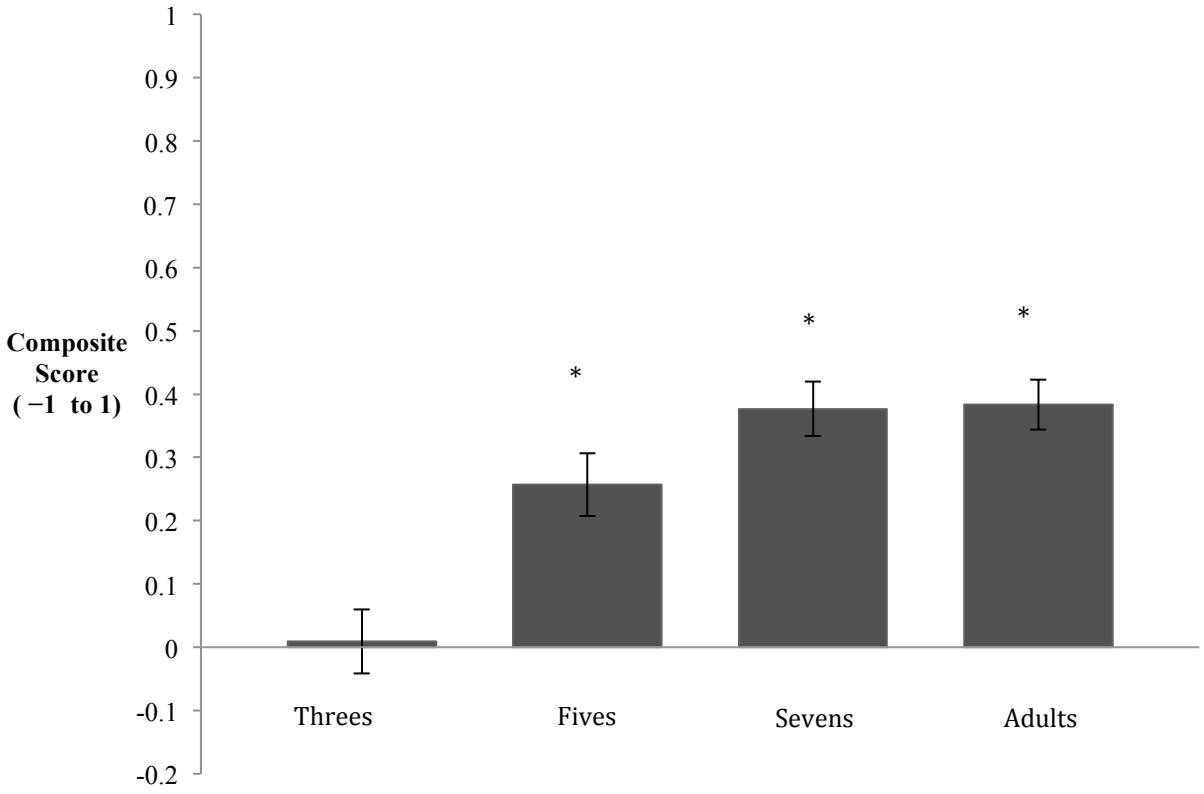

Figure 3. Composite Essentialism Scores across age groups (Three-year-olds, Five-year-olds, seven-year-olds, and adults, respectively). Scores could range from −1 (Anti-Essentialist) to 1(Essentialist). Composite scores were calculated as an average of the three essentialism tasks: Innate Potential, Metamorphosis, and Boundaries. Asterisks indicate significant difference from zero.

CHAPTER 4: STUDY 3, REPLICATING STUDY 2

In the preceding study, I found that three-year-old children show early signs of inherent thinking (as captured by measures of stability), but that these children do not show signs of essentialist reasoning. The goals of Study 3 were to 1) replicate the findings of Study 2 with different inherent thinking items for increased generalizability, and 2) to rule out the possibility that children's answers to the Stability questions simply reflected a yes-bias. Moreover, this new study included an enhanced warm-up procedure, as well as additional catch questions for each measure (i.e., Essentialism and Inherent Thinking), to further ensure that the three-year-olds could process the verbal material in our measures.

Participants. The participants were 32 three-year-old children (M_{age} = 3.79 years, *SD* = .27; 16 girls and 16 boys) who were recruited from a small city in the Midwestern United States. From the final dataset of 32 children total, 9 children were excluded from the Essentialism measure for failure to meet the criterion on relevant catch questions. Eight additional children were excluded from the Inherent Thinking measure for failing its relevant catch questions. Another 8 children were excluded from the sample altogether for failing the catch questions in both measures (see below for details). The children were mostly European American and represented a variety of socioeconomic backgrounds.

Materials and Procedure. The materials used were the same as in Study 1, except that I used new items for the inherence heuristic (instead of *birthday cakes* and *candles*, I asked children about the following patterns: "*TV are rectangles"* and "*Pajamas are for nighttime"*) and included a new warm-up and additional catch questions. For a complete description of these materials, see Appendix A.

Warm-up. Before the Boundaries and Metamorphosis tasks, children were given a warm-

up to make sure they understood the "Are they maybe right?" procedure. As in Study 1, children were introduced to a visitor named "Feppy." I then asked them the catch questions from Study 1. That is, children were asked a "no" question ("Feppy and his friends ALL say that your name is Sammy. Are they maybe right?") and a "yes" question ("Feppy and his friends ALL say that baseball is a sport. Are they maybe right?"). If children got a warm-up question wrong, they were corrected before moving on.

Catch questions. Recall that, in Study 2, I had only one set of catch questions (which was placed after the Essentialism measure), and children were excluded from the entire study if they got one catch question wrong. In this new study, I included a set of catch questions after both the Essentialism and the Inherent Thinking measures. Thus, children's responses to the inherent thinking items could be excluded while their responses to the essentialism items preserved, and vice-versa. Specifically, children were asked four catch questions for the Inherent Thinking measure (asked after the Inherent Thinking questions were completed), and five catch questions for the Essentialism measure. One of the Essentialism catch questions was asked after the Innate Potential items, and the other four were asked after both the Metamorphosis and Boundaries items. (This was because the Metamorphosis and Boundaries questions had a similar format, compared to the format for the Innate Potential items.) Because my main analyses examined the mean levels on individual measures, children could be excluded on the basis of the catch questions from just the Inherent Thinking measure, just the Essentialism measure,[14] or both.

Inherent Thinking Catch Questions. As children's inherent thinking was highest on Stability, my catch questions for the Inherent Thinking measure aimed to rule out the possibility of a Stability yes-bias. Children were asked two "yes" questions ("Do you think the sun has

[14] Children could have been excluded from just the Innate Potential task or just the Metamorphosis/Boundaries task, or both.

always been hot, even way back when the sun shone for the first time? Has the sun always been hot?" and "Do you think the sky has *always* been up, even way back when people first saw the sky? Has the sky always been up?") and two "no" questions ("Do you think you will *always* be three, even way into the future, when you're all grown up? Will you always be three?" and "Do you think you will *always* be sitting in that chair, even way into the future, when you're at home and not here anymore? Will you always be sitting in that chair?"). These catch questions were modeled after the Stability test questions. Children were excluded from the Inherent Thinking measure if they got more than one question wrong ($n = 8$).

Essentialism Catch Questions: Innate Potential. After the Innate Potential questions, children were told that "a seed that came from a pumpkin" was planted in a "pumpkin patch." As a catch question, they were then asked ("When the seed from the pumpkin grew, what popped up out of the pumpkin patch, was it a pumpkin plant or a tomato plant?"). No additional children were excluded from only the Innate Potential block. That is, children who got this catch question wrong ($n = 9$) also failed the catch criterion during the Metamorphosis/Boundaries items (see below), and were excluded from the entire Essentialism measure.

Essentialism Catch Questions: Metamorphosis/Boundaries. Finally, children were asked four catch questions after the Metamorphosis and Boundaries questions. As in the Inherent Thinking measure, children were asked two "yes" questions ("Feppy and his friends ALL say that kids go to school. Are they maybe right?" and "Feppy and his friends ALL say that some people like ice-cream. Are they maybe right?") and two "no" questions ("Feppy and his friends ALL say that trees can talk. Are they maybe right?" and "Feppy and his friends ALL say that dogs have wings. Are they maybe right?"). Children were excluded from the Metamorphosis and

Boundaries items if they got more than one of these catch questions wrong (n = 9). (These are the same 9 children who also got the Innate Potential catch questions wrong.)

Results

In the previous study, I found that three-year-old children show early signs of inherent intuitions, but do not display any signs of an essence assumption. In this study, I sought to replicate these findings with an inherent thinking measure that asked about different patterns (e.g., TVs being rectangles and PJs being worn at night). Moreover, extra catch questions were added to the Inherent Thinking measure and to the Essentialism measure to ensure the children included in the study understood the task.

Means and Correlations. As in Study 2, I first examined three-year-olds' mean levels of essentialism, to determine if they show signs of a belief in a causally powerful essence. Specifically, I conducted a one-sample t test to determine if children's composite Essentialism scores (M = .03, SD = .29) were significantly different from a neutral response (0 = neither essentialist nor anti-essentialist). Again, three-year-olds' Essentialism scores were no different from zero, $t(22) = .53$, $p = .603$. Three-year-olds' scores in this study, like those in Study 2, were not significantly different from zero on any of the three essentialism measures (Innate Potential, Metamorphosis, and Boundaries; all ps > .05). As predicted, these results replicate my findings from Study 2—that three-year-olds show no signs of having formed the belief in a causal essence (i.e., the "essence assumption"). Also, as in Study 2, none of the essentialism measures were significantly correlated, all ps > .05 (see Table 8 for full correlation matrix); again, this is not surprising given that three-year-olds do not show any signs of essentialism, and that previous work has found that young children's essentialism is not typically coherent (Gelman et al., 2007).

Next, I examined three-year-olds' inherent thinking. I conducted a one-sample *t* test to determine if a statistically significant difference existed between children's composite Inherence Thinking scores and a neutral response (0 = neither inherent nor anti-inherent). As in Study 2, three-year-olds' Inherent Thinking scores (M = .31, SD = .28) were significantly above the mid-point, $t(24) = 5.39$, $p < .001$. I also conducted a paired-sample *t* test to examine whether children's Essentialism scores (M = .07, SD = .27) and Inherent Thinking scores (M = .38, SD = .30) were significantly different from each other. Three-year-olds' Inherent Thinking scores were significantly higher than their Essentialism scores, $t(15) = 2.60$, $p = .02$.

When examining three-year-olds' scores on each Inherent Thinking measure separately, only their Stability scores (M = .64, SD = .55) were significantly different from zero, $t(24) = 5.82$, $p < .001$. As in the preceding study, children's Changeability scores (M = .23, SD = .68) and their Explanation scores (M = .05, SD = .28) did not differ from zero, both ps > .05. Children's scores on these measures were not correlated with one another, all ps > .05 (for full correlation matrix, see Table 8). Again, this may be explained by the fact that children did not seem to have strong intuitions about changeability or explanations, at least given my particular measures; thus, these variables may not be picking up meaningful variability in children's explanatory biases.

Individual Response Patterns. As in Study 2, these initial results seem to suggest that children may reason inherently before they develop the belief in a causal essence.
Using the classification system developed in Study 2, I again examined whether essentialists were more common among inherent thinkers than non-inherent thinkers. The relative frequency of essentialists among inherent thinkers was not significantly different than the frequency of essentialists among non-inherent thinkers, $p = .125$ (see Table 10 for frequencies). I also looked

specifically at children who were classified in one category but not the other (i.e., were essentialists or inherent thinkers). As in Study 2, a binomial test indicated that in this subset of children, there were significantly fewer children who were essentialists only (2 of 12 children) than children who were inherent thinkers only (10 out of 12), $p = .04$. Thus, the results reported here suggest that young children may engage in inherent reasoning before they develop the belief in a causal essence.

Discussion. Overall, the three-year-olds in this study behaved similarly to those in Study 2. Even when asked about a different set of social-conventional patterns, children showed signs of inherent intuitions before they seemed to show signs of essentialist beliefs. Recall that I had strict inclusion criteria in this study—only children who demonstrated that they understood the format of the tasks were included. Still, I found no traces of essentialist beliefs, but evidence suggesting that young children have early inherent intuitions. Moreover, there were more children capable of thinking inherently but not essentializing than there were children capable of essentializing but not inherent thinking.

It is important to consider what three-year-olds' inherent intuitions (as revealed in this study, as well as Study 2) mean for young children's concepts. Children seem to have strong beliefs about the stability of social-conventional patterns over time. Interestingly, in this study, as well as in Study 2, these beliefs were about patterns that fall outside the scope of essentialized domains. Specifically, the domains considered here (in regard to inherent thinking) are not domains in which children tend to believe that category membership is caused by a physical, nonobvious essence. (For example, young children do not typically believe that a physical, internal essence is causally responsible for the shape of TVs.) Thus, even though three-year-olds did not have strong intuitions regarding the malleability of conventions (i.e., Changeability), or

intuitions about the reason those patterns exist (i.e., their Explanation evaluations), they did display early intuitions distinct from (yet perhaps related to) essentialism. Taken together with previous work (e.g., Salomon & Cimpian, 2014; Sutherland & Cimpian, 2014), these findings suggest that early inherent intuitions may contribute to the development of essentialist beliefs.

Tables

Table 7: Three-year-olds Essentialism and Inherent Thinking Scores, Study 3

Measure	Mean	Std. Dev.	95% CI	p
Essentialism				
Innate Potential	0.16	0.78	−0.18, 0.50	0.340
Metamorphosis	−0.07	0.35	−0.22, 0.08	0.377
Boundaries	0.00	0.21	−0.09, 0.09	1.000
Average	0.03	0.29	−0.09, 0.15	0.603
Inherent Thinking				
Stability	0.64	0.55	0.41, 0.87	<0.001*
Changeability	0.22	0.67	−0.05, 0.51	0.106
Explanation	0.05	0.28	−0.06, 0.17	0.356
Average	0.31	0.28	0.19, 0.42	<0.001*

$N = 32$.

* $p < .001$.

Note: Scores could range from −1 (Anti-Essentialist) to 1(Essentialist) or −1 (Anti-Inherent) to 1(Inherent). Asterisks indicate significant difference from 0 (the midpoint).

Table 8. Correlation Matrices, Studies 2 and 3

Study 2: Three-year-olds

Measure	1.	2.	3.	4.	5.	6.
1. Innate Potential	—					
2. Metamorphosis	−0.22	—				
3. Boundaries	−0.04	0.06	—			
4. Stability	−0.06	−0.27	0.22	—		
5. Changeability	−0.31	0.08	0.24	−0.08	—	
6. Explanation	−0.04	−0.07	0.26	−0.02	0.07	—

Study 3: Three-year-olds

Measure	1.	2.	3.	4.	5.	6.
1. Innate Potential	—					
2. Metamorphosis	−0.04	—				
3. Boundaries	0.00	−0.15	—			
4. Stability	−0.44	−0.19	0.15	—		
5. Changeability	0.07	−0.22	−0.19	−0.01	—	
6. Explanation	0.03	0.03	0.11	−0.16	−0.13	—

Table 9: Descriptive Statistics for Metamorphosis and Boundaries Tasks, Studies 2 & 3

	3-year-olds: Study 2		3-year-olds: Study 3	
Measure	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Metamorphosis				
Animals	0.56	0.45	0.50	0.50
Tools	0.55	0.43	0.57	0.46
Boundaries				
Animals	0.56	0.44	0.46	0.48
Tools	0.47	0.46	0.46	0.45

Note: Responses for both Metamorphosis and Boundaries items were coded on a 0/1 scale (yes = 1; no = 0), and averaged across animal and tool trials separately.

Table 10. The frequency of *inherent thinkers* and *essentialists* in Study 3

		Inherent Thinkers	
		Yes	No
Essentialists	Yes	0	2
	No	10	4

CHAPTER 5: GENERAL DISCUSSION

The research described here had two goals. First, I set out to develop a new set of essentialism measures that could adequately capture the *essence* assumption—that an underlying, physical structure or quality (i.e., an essence) causes category membership and gives rise to category-typical properties. Research on essentialism to date has not carefully mapped out which measures tap which aspects of people's essentialist reasoning, so it was important to begin to clarify this issue. Second, I sought to fill an important gap in the essentialism literature by examining a possible precursor to essentialist beliefs—namely, an early-emerging explanatory bias that leads children and adults to explain via inherent information (i.e., the inherence heuristic; Cimpian & Salomon, 2014). Although it has been discussed, little work has exposed the foundation of essentialist beliefs. To add to a growing body of work supporting inherent thinking as a precursors to essentialism (Salomon & Cimpian, 2014; Sutherland & Cimpian, 2014), I investigated the unique prediction that inherent thinking develops *before* the onset of essentialist beliefs. As essentialism is thought to begin no earlier than age 4, I tested the presence of essentialism and inherent thinking in 3-year-old children.

In line with Goal 1, I successfully developed and validated measures that more accurately assess the belief in a causal essence. My design involved measures intended to capture: 1) the belief that category identity is determined at birth, 2) the belief that animals (vs. artifacts) retain identity over metamorphosis, and 3) the belief that category boundaries are strict for animals (compared to that of artifacts). If properly designed, these measures should test the understanding that nonobvious features have causal importance for categories, and thus tap into intuitions beyond the kind assumption (i.e., the belief that natural categories have many commonalities). Indeed, in my validation study, children and adults gave developmentally

appropriate responses. A number of developmental studies have shown that children understand the causal importance of nonobvious features (such as essences) for categories by age five, and this understanding becomes more sophisticated as children age (e.g., Gottfried et al., 2005). In the data reported here, five-year-old children show early signs of essentialist reasoning, and this reasoning is more apparent when children reach the age of seven; moreover, essentialist intuitions of this sort seem to remain present in adulthood. Thus, these improved measures of essentialism seem to adequately test the essence assumption as intended. Researchers interested in capturing children's assumptions about essences (beginning at age three) should consider using these revised measures in future work, or rely on them as a guideline when developing studies of a similar nature.

In line with Goal 2, I provide evidence that an early explanatory bias (i.e., the tendency to reason inherently) might predate essentialism. In Study 2, I showed that children at age three are neutral in regards to essentialist reasoning. The same children show signs of inherent thinking, particularly on measures of stability. Notably, children were significantly more likely to show signs of inherent thought in the absence of essentialism than they were to show signs of essentialism in the absence of inherent thinking. In Study 3, I replicate this finding with a revised measure of inherent thinking and more precautions to ensure children understood the task. These findings provide further evidence that inherent thinking may precede essentialism. Understanding potential precursors to essentialist thought may be an important first step in uncovering the developmental origins of essentialist beliefs.

Still, there remain a number of limitations of the research reported here. It is important to note that children most strongly endorsed the stability of social-conventional patterns over time, but had relatively neutral beliefs regarding the necessity of these social patterns as well as the

reasons why these patterns exist. According to the inherence heuristic account (Cimpian & Salomon, 2014), beliefs about stability form as a downstream consequence of inherent intuitions. However, it is also possible that the data reported here don't reflect an inherence bias per se, but instead a bias to believe that patterns generally remain stable over time. Early in life, children may assume that much of their environment remains stable and unchanging, and thus come to assume that the world is generally structured as such. Thus, a stability assumption—rather than an inherence bias in explanation—may precede essentialism. However, the stability measure used in my studies was simpler than the other inherence measures, and could have been the only measure that captured any aspect of children's intuitions. Thus, stability intuitions may derive from inherent thinking, but I was not able to adequately capture that possibility in the studies reported here.

Another limitation of the present research is that the design heavily relied on children's verbal skills, which might make it difficult to translate these measures for work with younger samples. In order to fully understand the developmental sources of essentialism, however, it is important to examine the presence of these beliefs as early in development as possible. Although language is not explicitly required for category learning and inference—as even prelinguistic infants can learn categories (Baldwin, Markman, & Melartin, 1993; Mehler & Fox; 1985)—it remains unknown whether essentialism, an abstract phenomenon, can be tested without language. Moreover, it might be even more challenging to compare other constructs to essentialism (e.g., the inherence heuristic) without verbal instruction. Thus, future work might attempt to develop, if possible, ways test the presence of essentialism using nonverbal tasks.

Although I have provided evidence for a possible precursor to essentialism, there is still much to learn about the developmental course of essentialist thought. Future work may test the

more general claim that inherent thinking not only precedes essentialism, but also gives rise to it. Perhaps, inherent thinking, along with other early cognitive biases (e.g., the ability to distinguish appearances from reality or the tendency to search for causes) contributes to the formation of essentialist beliefs across development. If early signs of inherent thinking predict essentialist beliefs later in development, that might suggest that inherent thinking indeed lays the foundation for essentialist beliefs. It would be interesting to examine this possibility in a longitudinal design, which could track changes in individuals' inherent thinking, as well as their essentialism, to understand their relationship over time across different points in development. It would also be interesting to examine how the different components of inherent thinking might inform the different components of essentialist reasoning across the lifespan. As children's essentialist and inherent intuitions become more refined and sophisticated with time, we might observe predictive relationships across the different aspects of both constructs (for example, perhaps stability beliefs will be predictive of the belief in category constancy across metamorphosis). The data reported here cannot speak to this issue, as children's essentialism and inherent thinking were not related. However, these intuitions might be related in older children (as they are in adults; see Salomon & Cimpian, 2014). Thus, future research may aim to understand the possible array of relationships between the different strands of inherent thinking and essentialism across different developmental time-points.

Another unknown is the extent to which the tendency to think inherently varies by domain, and how such variation might be related to variation in essentialist beliefs. The bias to explain via inherent thinking is thought to influence a number of domains—including social-political patterns (Hussak & Cimpian, 2015), early scientific beliefs (Horne & Cimpian, 2015), and intuitions about words and language (Sutherland & Cimpian, 2015). However, the extent to

which inherent explanations may influence reasoning in some domains more than others has not explicitly been examined. It would be interesting if inherent explanations pertaining to certain domains (e.g., social groups) influence the development of essentialist beliefs more than inherent thinking pertaining to other domains (e.g., man-made objects). Future work might examine these and other such possibilities.

What do the findings reported here mean for the broader scope of cognitive development? In many ways, the study of young children's essentialist beliefs changed the mindset of cognitive development as a field. Early developmental accounts painted children's concepts as shallow and unsophisticated (Piaget, 1970); however, evidence of children's ability to essentialize suggested that young children's concepts must involve more than a reliance on perceptual features. The studies reported here support an early-competence view of children's concepts in two ways. First, Study 1 found that children show signs of the belief in a causal essence as early as age five. This study was done with revised essentialism measures, lending credibility to early work done in the same vein. Second, Studies 2 and 3 provide evidence that as early as age three, children have informative intuitions about how the world is structured, and these intuitions seem to be informed by beliefs pertaining to inherence. These studies are the first to show that children as young as three years of age engage in inherent reasoning, and add to a growing body of work suggesting that biases in explanation play a formative role in children's concepts (Hussak & Cimpian, 2015; Salomon & Cimpian, 2014; Tworek & Cimpian, 2016).

Still, some might argue that young children do not have theories at all, and that their "competence" is the result of learning simple associations, or "dumb attentional mechanisms" (see the "DAM" theory; Smith, Jones, & Landau, 1996). This contrasts with the "theory theory" view supported by essentialism (Gelman, 2003) in how it accounts for the very nature of

cognitive development. According to the "DAM" theory view, children primarily use perceptual information to make inferences, and with repeated experience learn to make associative connections to inform their concepts (e.g., linguistic contexts). "DAM" theory does not assume that children have a built-in skeletal framework that guides concept formation, but instead that cognition undergoes a developmental shift from perceptual to conceptual through learning processes. Other accounts support similar developmental shifts. For example, Gentner and colleagues argue for a relational shift during development, such that children first understand analogy by reasoning about shared object attributes, and only later in development are they able to reason about relations (Gentner, 1988; Ratterman & Gentner, 1998). In a similar vein, Keil and Batterman (1984) suggest that children's concepts undergo a categorical shift, such that young children use characteristic features to make category inferences and it's only with age that they recognize the importance of defining features.

These accounts, including "DAM" theory, are appealing in that they provide a more mechanistic explanation for the developmental changes in categorization that occur during early childhood. In contrast, the "theory theory" view holds that cognitive development is continuous: children have rather sophisticated (though skeletal) concepts early on that may be shaped by learning and experience (Gelman, 1996; Gelman, 2003). Children certainly take into account perceptual features during categorization, but the theory view would maintain that children use this perceptual information along with information about the nonobvious (see discussion by Gelman & Medin, 1993).

The present research, as well as much of the essentialism literature, suggests that children do have theories by at least age four—that is, they incorporate causality as well as hidden, nonobvious properties into their concepts. What precedes children's theory-based concepts

before the preschool years? Although many researchers would maintain that children's concepts are never atheoretical (e.g., Bloom, 2000), it's certainly possible that some sort of developmental shift occurs before four years of age. How might the data reported here inform this possibility? It may seem as though inherent thinking could involve a reliance on concrete, perceptual properties; indeed, the explanation process *does* rely on salient information that likely comes to mind first, which in many cases, may be obvious perceptual information. Thus, if inherent thinking gives rise to essentialism across development, one might argue that this transition could be an instantiation of a perceptual to conceptual or an object to relational shift. However, the inherence heuristic account does not suppose that inherent information is necessarily concrete or perceptually obvious—inherent explanations may instead take an abstract form and even rely on hidden properties and their relation to patterns (Cimpian & Salomon, 2014). The data reported here does not necessarily speak to this issue, as children were not asked to generate their own explanations and the nature of the tasks used does not tell us what type of inherent information children might attend do (e.g., obvious or non-obvious). In order to understand how essentialism might derive from inherence, it may be important to examine these constructs with different measures and with younger samples. Doing so may help researchers understand the nature of cognitive development more broadly.

The present research may also be informative for work aimed at reducing the downsides to essentialist thought. The widespread belief that social categories possess "essences" leads children and adults to exaggerate within-category homogeneity, and as a result, endorse stereotypes for many social groups (Bastian & Haslam, 2006; Hoffman & Hurst, 1990; Levy & Dweck, 1999; Martin & Parker, 1995; Pauker, Ambady, & Apfelbaum, 2010; Plaks, Stroessner, Dweck, & Sherman, 2001; Prentice & Miller, 2007). Essentialism also makes people more likely

to attribute group differences (e.g., more men working in computer science than women) to natural, biological causes (e.g., men are more intellectually gifted than women) as opposed to social or cultural factors (e.g., bias against women in STEM fields) (Leslie, in press; Martin & Parker, 1995; Salomon & Cimpian, 2014). These and other similar attributions make people more likely to justify the status quo and accept social inequalities (e.g., men being paid more in computer science than women) (Cimpian & Salomon, 2014; Hussak & Cimpian, 2015; Jayaratne et al., 2006). Thus, studying the origins of essentialist thought might help us to better understand how these incorrect and harmful beliefs are formed, and how they may be effectively prevented.

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APPENDIX A: STUDY MATERIALS

INNATE POTENTIAL (STUDIES 1-3)

This seed came from an [orange/lemon/rose]. A girl named Jennifer took this seed out of the orange. Then she planted the seed in a [flower pot/ cornfield/vegetable garden]. See, here's the [flower pot/cornfield/vegetable garden]. Now I'm going to ask you some questions.

So where did the seed come from? And where did [Jennifer/Ashley/Lauren] plant this seed?

When that seed grew, what popped up out of the ground, was it an orange tree or a flower?

Orange Seed

Lemon Seed

Rose Seed

Flower Pot

Cornfield

Vegetable Garden

"FEPPY INTRODUCTION" (STUDIES 1-3)

"This is Feppy. Feppy is a visitor from a place far far away where they do lots of things differently than we do. Some of the things they do are wrong, but some of the things are just different.

These are Feppy's friends.

Your job is to help me figure out when Feppy and his friends say something wrong and when Feppy and his friends say something that is maybe right, but just different."

METAMORPHOSIS (STUDIES 1-3)

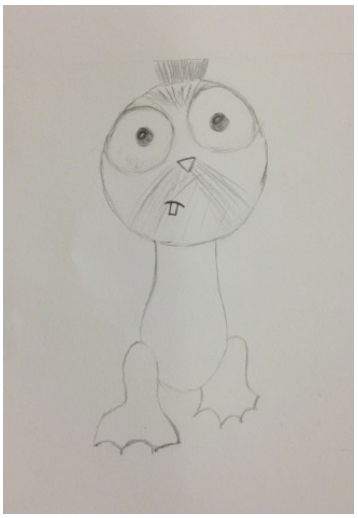
Animals:

Here is a baby [Dax/Frip]. [Daxes/Frips] are animals. And this is a baby [Dax/Frip]. Here is another picture. Let's see what Feppy says about this new picture.

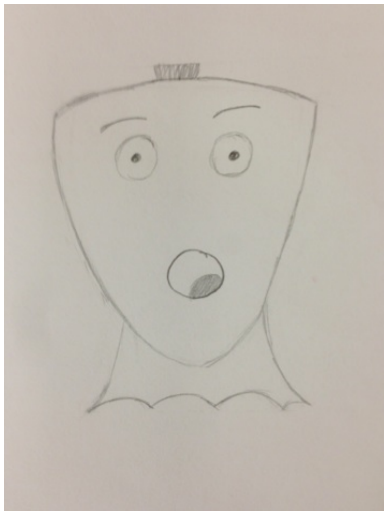
Feppy and his friends ALL say that this is what [Daxes/Frips] look like when they are adults.

Are they maybe right? [Yes/ No]

Baby Dax



Adult Dax



Baby Frip

Adult Frip

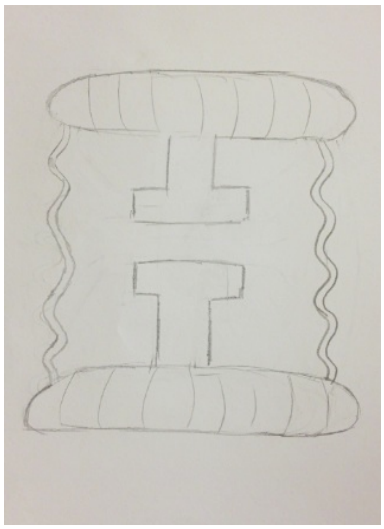
Tools:

Here is a brand new [Blick /Joop]. [Blicks/Joops] are tools. And this is a brand new [Blick/Joops] (point again). Here is another picture. Let's see what Feppy says about this new picture.

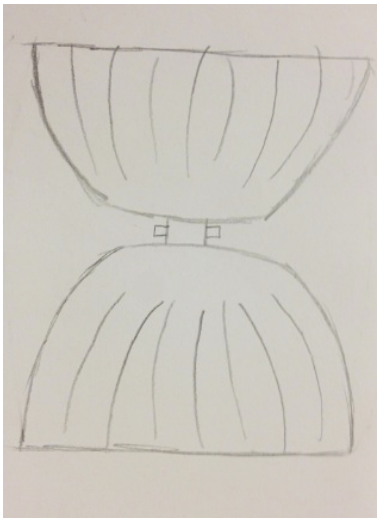
Feppy and his friends ALL say that this is what [Blicks/Joops] look like after they have been used for a while.

Are they maybe right? [Yes/ No]

New Blick

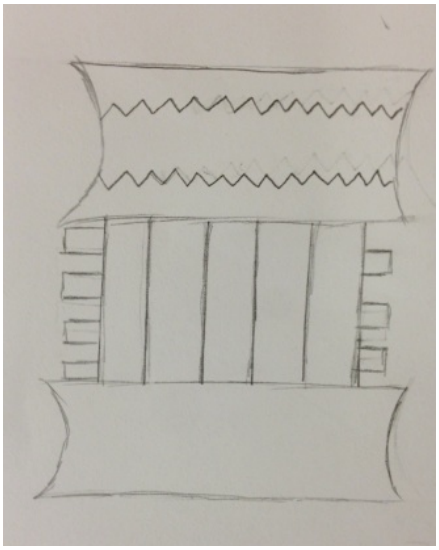


Used Blick



New Joop

Used Joop



BOUNDARIES (STUDIES 1-3)

Here are a couple of things. Let's see what Feppy says about them. Feppy and his friends ALL say that these are the same kind of thing.

Are they maybe right? [Yes/ No]

Animal pairs:

Artifact pairs:

INHERENT THINKING MEASURE (STUDIES 2 & 3)

Using the "birthday cakes have candles" fact:

Stability:

Question 1a: Do you think birthday cakes have always had candles, even way back when the first ever birthday cake was made? Have birthday cakes always had candles?

Question 1b: Do you think birthday cakes will always have candles, even way into the future, when the very last birthday cake is made? Will birthday cakes always have candles?

Scoring: 0 = "no", 1 = "yes"

Changeability:

Question 2: Imagine if people wanted birthday cakes to not have candles, and everyone agreed that they wanted birthday cakes to not have candles. Would it be okay to make this change? Would it be okay to make a change so that birthday cakes do not have candles?

Children could respond with "yes" or "no." If they responded with "no," the experimenter asked a follow-up:

Would it be sort of not okay, not okay, or really not okay to make a change so that birthday cakes don't have candles?

Scoring: 4-point scale (1 = "okay" to 4 = "really not okay")

Explanation:

Okay, so I was talking to some friends about why birthday cakes have candles.
Here are two reasons that my friends came up with. I wanted to know what you think of these reasons…

Ok, so one person said that birthday cakes have candles….

Question 3 [EXTRINSIC]: … just because people thought it might be a nice idea. But birthday cakes don't really have to have candles.

Is this person right or not right to think that birthday cakes have candles just because people thought it might be a nice idea? *

[**Question 3 [INHERENT]:** …just because they are birthday cakes. And birthday cakes have to have candles.

Is this person right [point] or not right [point] to think that birthday cakes have candles just because they're birthday cakes?

Children could respond with "right" or "not right." The experimenter followed-up with a scale for each response.

Scoring: 4-point scale (1 = "really not right" to 4 = "really right")
* Indicates reversed scoring

BOUNDARIES/METAMORPHOSIS CATCH QUESTIONS (STUDY 1 & 2)

1. Feppy and his friends ALL say that baseball is a sport. Are they maybe right? [Yes/ No]

2. Feppy and his friends ALL say that your name is Sammy. Are they maybe right? [Yes/No]

BOUNDARIES/METAMORPHOSIS CATCH QUESTIONS (STUDY 3)

1. Feppy and his friends ALL say that kids go to school. Are they maybe right? [Yes/ No]

2. Feppy and his friends ALL say that trees can talk. Are they maybe right? [Yes/ No]

3. Feppy and his friends ALL say that some people like ice-cream. Are they maybe right? [Yes/ No]
4. Feppy and his friends ALL say that dogs have wings. Are they maybe right? [Yes/ No]

INNATE POTENTIAL CATCH QUESTION (STUDY 3)

This seed came from a pumpkin. A girl named Katie took this seed out of the pumpkin. Then she planted the seed in a pumpkin patch. See, here's the pumpkin patch**.** Now I'm going to ask you some questions.

So where did the seed come from? And where did Katie plant this seed?

When the seed from the pumpkin grew, what popped up out of the pumpkin patch, was it a pumpkin plant or a tomato plant?

INHERENT THINKING CATCH QUESTIONS (STUDY 3)

1. You know how the sun is hot, right? The sun is hot. Do you think the sun has always been hot, even way back when the sun shone for the first time? Has the sun always been hot? [Yes/No]

2. You know how you're 3-years-old, right? You're three! Do you think you will always be three, even way into the future, when you're all grown up? Will you always be three? [Yes/No]

3. You know how the sky is up, right? The sky is up. Do you think the sky has always been up, even way back when people first saw the sky? Has the sky always been up? [Yes/No]

4. You know how you're sitting in that chair, right? You're sitting in that chair! Do you think you will always be sitting in that chair, even way into the future, when you're at home and not here anymore? Will you always be sitting in that chair? [Yes/No]